SCIENTIFIC AMERICAN
No. SUPPLEMENT 59

Scientific American Supplement, Vol. III, No. 59.
Scientific American, established 1845.

NEW-YORK, FEBRUARY 17, 1877.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

THE INTERNATIONAL EXHIBITION OF 1876.

TESTS OF TURBINE WATER WHEELS.

EARLY in the organization and arrangement of the machinery department of the Centennial, quite extensive preparations were made for an efficiency test of the turbine wheels, placed on exhibition, and, as this class of motors is now so universally in use, and has so completely supplanted all other systems of utilizing the power of falling water, a description of the manner of conducting these experiments, the apparatus used in the determination of the relative efficiency of the machines, and a comparison of the results of the tests, will be acceptable to your readers. The utilization of the power resident in natural waterfalls ranks among the oldest of man's efforts to escape the use of animal power, and particularly the expenditure of his own muscular energy; and its inherent cheapness has rendered this one of the most promising fields for the exercise of his inventive genius. From the crude apparatus employed in blowing the old Catalan iron furnaces (by permitting a column of water to fall through a perpendicular box, perforated at or near the top to admit the air, which was carried downward to a pressure chamber at the bottom, whence it was led to the tuyere by the mere friction and entanglement of the air by the water)—and this was probably the least efficient of any method ever attempted of obtaining work from falling water—to the most perfect turbine of to-day, men have cudgeled their brains, experimented and invented, with a slow but sure improvement through centuries, until now they have succeeded in bringing out of the crude machinery instanced above, which rendered up but an insignificant fraction of the theoretical power of the water, machines which give to the performance of actual and useful work from 60 to 90 per cent. of the energy resident in the water. It is interesting in these days of diligence and deep research, with the view of obtaining some means of utilizing the enormous quantities of heat reaching us daily from the sun for purposes of power, and in view of the fact that our steam engines are so rapidly consuming the vast stores of the past energy of that luminary, as potentially represented in our coal fields, to think that, even the original crude and most wasteful form of the water wheel, was a more perfect machine than the highest type of modern steam engine; while, as a sun engine, or a machine through which we may transmute solar heat into actual energy for our own use, the modern water wheel exceeds in efficiency anything man can hope to discover to devise.

The potential energy of a body of water at any level represents perfectly and without loss the equivalent of the heat of the sun expended in raising it to that level by evaporation from the ocean or other body of water at a lower level, and the machine which will appropriate and render up as useful work 90 per cent. of this energy in its descent from this to the level at which it was evaporated, is considered as a heat (or sun engine, which in reality it is) about six times more efficient than the most efficient steam engine yet constructed. It is not, however, by any means to be claimed for the turbine wheel that it has in the past, even as it now does, represent the highest type of efficiency in the water wheel; for the comparatively old device, the overshot wheel, had for a long time been unapproached in that respect, and it is only within a comparatively few years that a turbine wheel has been at all comparable with it. The overshot wheel is, however, so objectionable in many other respects, such as space occupied, original cost, inapplicability to extremes of fall, either high or low, etc., while the turbine is small, cheap, adaptable to any head of water, and possesses so many advantageous characteristics, that improvement in water wheels has been sought in this direction only for years past; and so near have inventors reached in this the theoretically perfect machine, that now the best turbine wheels give us very nearly all that can come from the water, in shape of work, that is possible until we shall succeed in obliterating friction of water in pipes or conduits, and upon the surfaces of the machine, and that of the parts of the machine within itself, which of course can never be hoped for; and now the principal field for improvement is in such things as relate to cost, endurance, immunity from destruction, or loss of power from clogging by obstructions in the water, government of speed under variations in the load upon them, reliability of working parts, provision for a successful encounter with freezing weather, and others less important; while, perhaps, the most evident direction in which the turbine is still capable of improvement, and in which it is most sought, is that of increasing its efficiency under a diminished flow and nearly constant head of water, or under what is technically known as partial gate. Of course it is not intended to convey the idea that there are not many turbines in use which do not approach the efficiency of the best, or that there is not a great difference in them in that respect, even while working under a full gate; as the results given here show that the wheel which gives over 80 per cent. of efficiency, under the most favorable conditions, is the exception, and those giving less the rule.

It appears, so far, to be one of those almost insuperably difficult things to overcome in the water wheel that is encountered so often in mechanical constructions, and from which there appears to be well nigh no escape, that, under the circumstances in which their efficiency is of the greatest moment, is just where they are the least efficient; and while they have lately been much improved in this respect, there is yet much to be desired, and room still for a great improvement. Where a water wheel is situated upon a stream which in the drier seasons supplies a lesser quantity of water than the wheel is competent to utilize when in full flow, it is of the utmost consequence, and more than at any other time, that all the power possible shall be gotten from the diminished stream, and it is most unfortunately true of even the best wheels that, at such a time, they come considerably short of their maximum efficiency, thus wasting the water when it is most precious; and what is true of the best in this respect is exaggerated in the less generally efficient wheel; so that it is in this direction that inventors may work for the most desirable future improvement in this instrument, as indeed it has been a field for the most severe and persistent investigation and study in the immediate past. Such questions, too, as that of leakage of gate and depreciation of efficiency from various causes after considerable use, and many other minor ones, have to be considered in deciding upon the merits of a wheel, and of late years much thought has been expended and experiment had with the view of improving such machines in all these particulars.

It is to be regretted that the Centennial tests were not, all of them, of longer duration; for while it was not to be hoped that they could have been continued sufficiently long to properly determine any other question than their efficiency, it is presumptively true that the longer the duration of the tests the more reliable would be the results obtained; and it will be the opinion of many that they were of too limited duration to be entirely beyond question. The arrangements were, however, so admirably conceived, and the apparatus so well devised throughout, that the shortness of the periods allotted to each separate test were largely compensated for, and they were invariably continued until the exhibitor expressed himself satisfied.

The arrangement and construction of the apparatus with which these tests were made is shown in the five first figures: Fig. 1 is a plan, Fig. 2 a rear elevation, and Fig. 3 an end elevation of the arrangements for supplying the head and quantity of water required. This consisted of a boiler iron tank, G, 36 feet long, 18 feet 6 ins. wide, and 5 feet 6 ins. deep, supported upon six cast iron columns, C, three of them erected upon a pier, P', built in the main basin. This tank held when full about 19,000 gallons. Upon the side of the tank next to the main basin was formed a curved overflow, over which the surplus water flowed into the basin, thus enabling the experiments to be conducted under a practically constant head. The curved form of this part of the tank is seen at *g*, Fig. 3. The tank was supplied by two of Wm. D. Andrew's centrifugal pumps, *p*, having discharge pipes 15 inches in diameter, and under a total head of about 32 feet. The discharge pipes are shown at D, in part broken, in Fig. 3. On the left in the same figure will be seen the penstock tube, P, 4 feet in diameter, leading vertically downward from the bottom of the tank, its lower end terminating as seen in one right angled turn where it enters a cylindrical case, or flume, 8 feet 6 inches in diameter, supported on a circular brick wall, within which each wheel was placed to be tested. Fig. 4 shows in plan the position of race, weir, etc. From the bottom of the wheel pit the tail race, T, led out directly to the channel between the end of the main basin and the pier, P', erected within it. At one side of the tail race this channel was closed by a brick and cement wall, W'; upon the other side the water passed to the end of the pier, and around into an inclosed weir basin, built up in the main basin, enlarging its width from the wheel toward the weir to a point about 30 feet from the wheel pit, where it was 15 feet wide; and at that point was placed a rack, or strainer, extending to the bottom of the weir basin, which was 14 feet 8 inches deep. The overflow was placed 15 feet from this rack, and consisted of a cast iron plate accurately planed and bevelled at an angle of 45 degs. until the straight edge was ¼ inch thick. The inside of this plate was vertical, and the bevel side placed down stream. This plate was 9 feet long, leaving three feet of the end wall of the weir basin on each end, so that end contraction of the vein

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had to be accounted for. The vertical ends were made of pine, bevelled precisely like the horizontal iron plate, and were so placed as to make the weir opening exactly 9 feet long. The distance of the weir in a direct line from the wheel was about 45 feet.

The depth of water upon the weir was determined by the usual hook gauge, placed in an inclosed box, perforated near the bottom with ½ inch holes, to insure a perfectly quiescent level from which to read the head. This gauge was furnished with a vernier which read to $\frac{1}{500}$ of a foot, and the whole was placed at a point back from the weir beyond that at which depression of the surface commences (6 feet from weir), and the vernier was set with reference to the edge of the weir plate as a datum plane. The head of water on the wheel was measured from the level of water in the tail race by a hook gauge (in a closed box, as with the other), adjustable by an attendant at the lower level by means of a screw; this gauge being extended upward by a wooden rod, upon the upper end of which was a vernier reading to $\frac{1}{50}$ of a foot. Opposite this vernier was situated a glass tube gauge connected with the flume, which indicated the head of water upon the wheel. In this way the reading of the vernier at the level of the water in the tube gave the exact difference of level between that due the head of water on the wheel and the tail race, or the true head upon the wheel; the water in the tail race being backed up in all cases to the level of the draft tube of the wheel, or to that at which the owner considered his wheel would run best.

The revolutions were determined by an indicator actuated by a worm upon the first axis, divided by gearing to a single index and dial divided to one hundred. This counter was so constructed as to be connected to or disconnected from the wheel shaft at will, so that at a given signal, with the index at zero, it might be connected, and at the expiration of the run, at a similar signal, disconnected, exhibiting the total revolutions for the period run. The runs made were nearly all for two minutes, all other data being taken every half minute. The tests lasted from one to two and a half hours, as decided by the number of fractional gate tests desired by the owners of the wheels, and varied all the way from five or six to twenty or twenty-five runs for each wheel.

The apparatus used for the determination of the work of the wheel is shown in Figs. 5, 6, and 7. Fig. 5 is a side view, partly in section, and Fig. 6 a top view of the ordinary Prony brake, whose plane of effort is in this case horizontal. Keyed to the water wheel shaft is a hollow cylinder, *c*, Figs. 5 and 6, 37·44 in. diameter and 18 in. face, runs within two semi-cylindrical straps, *c'*, one of which terminates in a lever arm, L. In the inside of these straps are inserted strips of hard wood, running in the direction of the axis of the wheel, and in these were scored zig-zag grooves to permit of the percolation of the lubricating material. These straps were adjusted as to pressure upon the cylinder by the bolts, *b b*. Fig. 7 is a standard frame, upon which is pivoted at its cen-

Fig. 1.

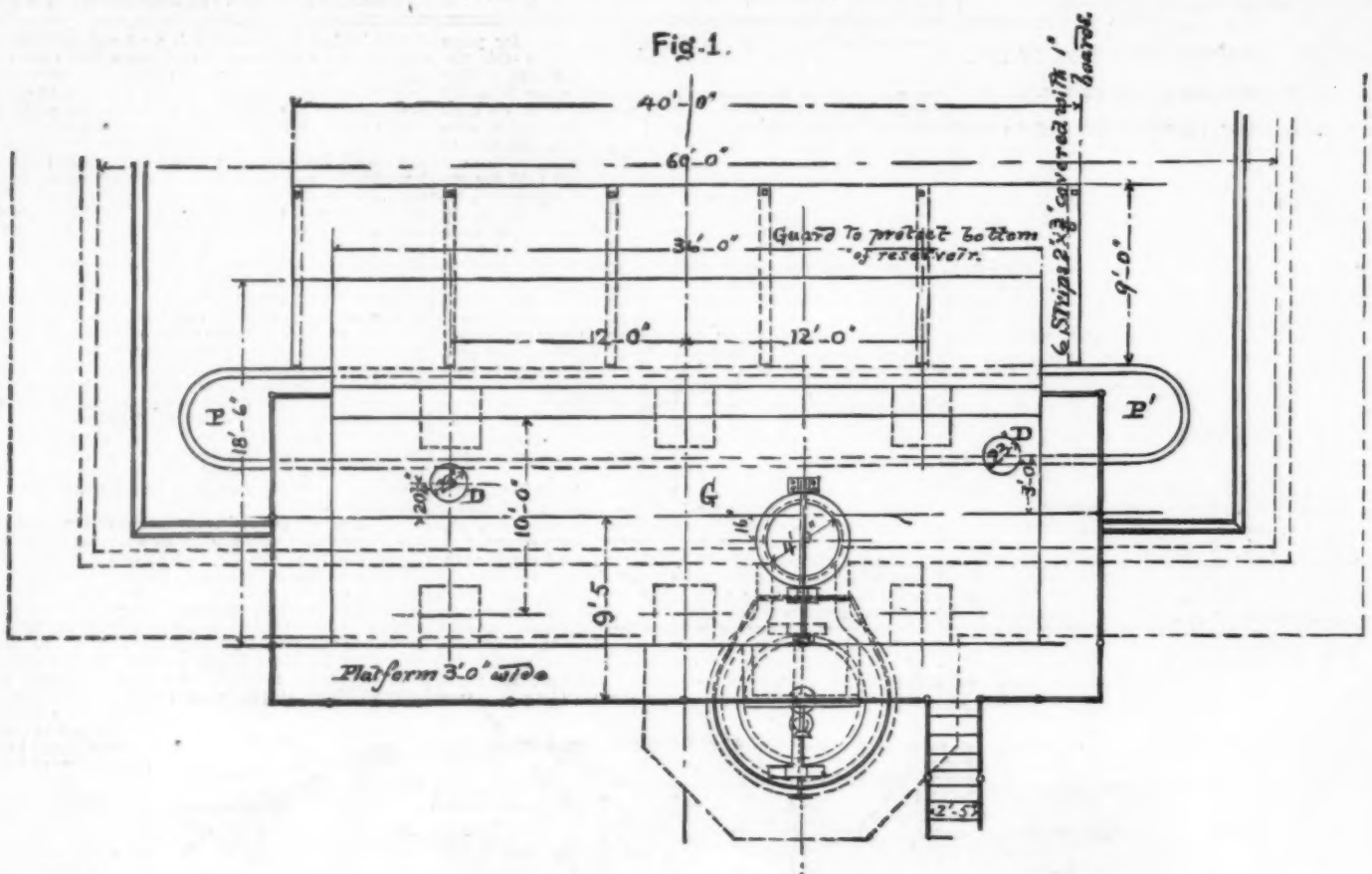
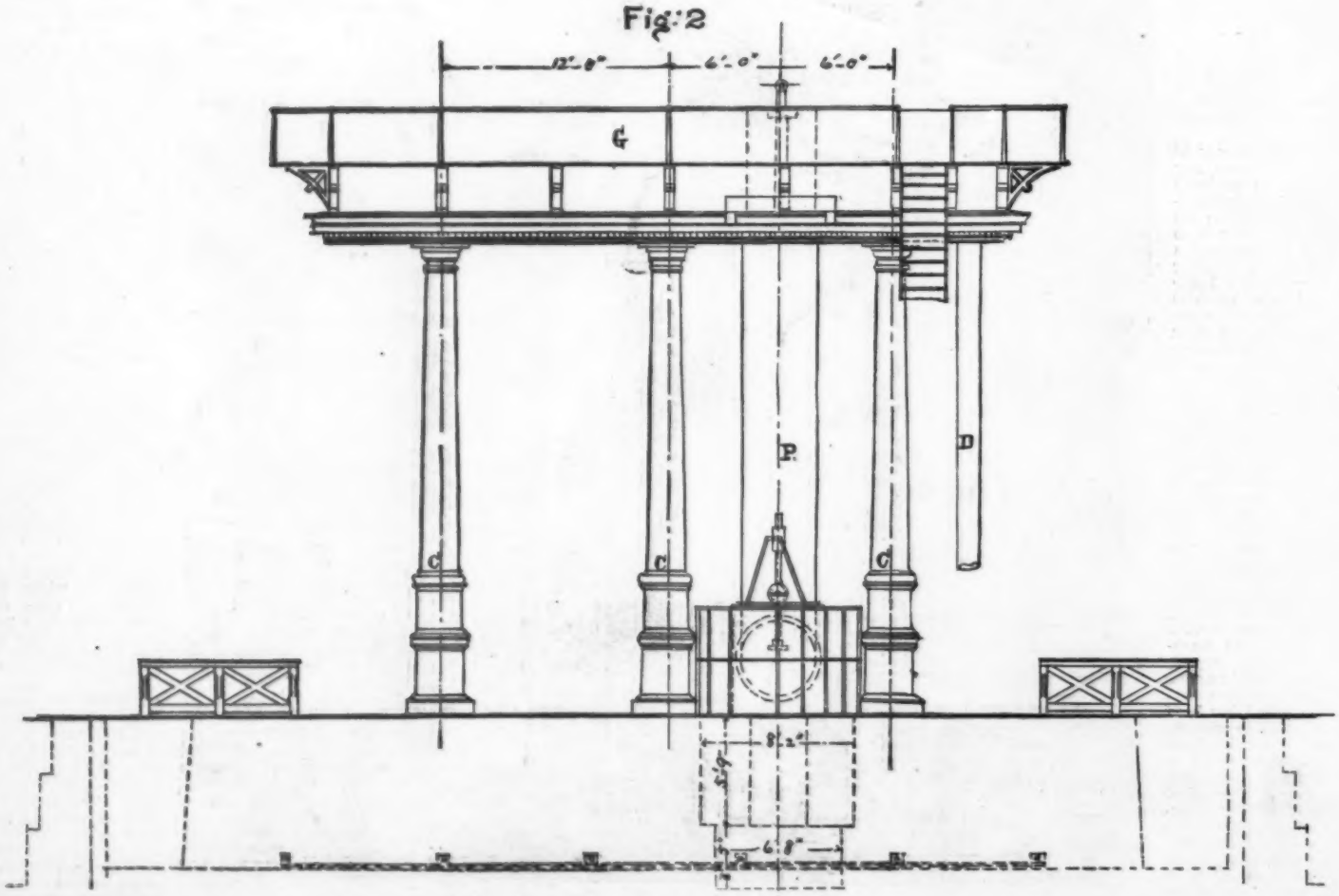


Fig. 2



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ter, *f*, a horizontal lever, L. The pivot, *f*, is a knife edge resting in hardened iron sockets. At right angles with this lever, extended vertically, is an arm, *a*, properly braced, from which a rod or cord, *r*, connects to the end of lever, L, where is placed a knife-edged eye-bolt to receive it. The arms of this bell crank, which it virtually is, are 4 feet and 2 feet long, giving them, as measured from the points of application, the proportion of 2 to 1. From one end of L' was suspended an ordinary scale pan or platform, and from the other extended downward a rod terminating in a plunger working in the usual dash pot, to prevent vibration. The weights used were the U. S. standard, furnished by Fairbanks & Co. The whole apparatus when without weights upon the scale pan was accurately balanced, and the weight of the lever, L (1,600 lbs.), was taken up by a counter-balance, not shown in the sketch, in order to relieve the stop of the wheel of the weight of this part of the apparatus. The friction drum weighed about 1,000 lbs., and its weight was taken on the stop, being considered as practically equivalent to the weight of the gearing attached to the shaft of such wheels in ordinary practice.

The virtual length of the lever, L, was that of the radius to a circle 66 feet in circumference; made to this dimension to facilitate computation; thus:

Let W = weight upon scale pan,
" R = revolutions per minute,
" C = circ. due to lever arm = 66 feet.

Then—the levers L' and *a* being in the proportion of 2 to 1—we have:

$$\frac{2WRa}{33000} = \frac{WR}{250} = \text{H. P.}$$

To find the horse power of the wheel, therefore, it was only necessary to multiply the product of the weight and revolutions by 4 and point back three decimal places—a very simple operation.

The brake was lubricated with a solution of soft soap in water in the proportion of about a pailful of soap to a barrel of water. This was fed from a can communicating with a hole in the brake strap opposite the termination of the zig zag grooves. The heat developed was carried off by permitting a small stream of water to run from a pipe from the lower part of the penstock into the interior of the hollow drum, and to overflow down into the race as it might; some of it also passed away through holes made in the bottom of the drum. An attendant was placed at the brake bolt, *b*, to regulate the tension, as at the other stations.

(To be continued.)

Fig. 3.

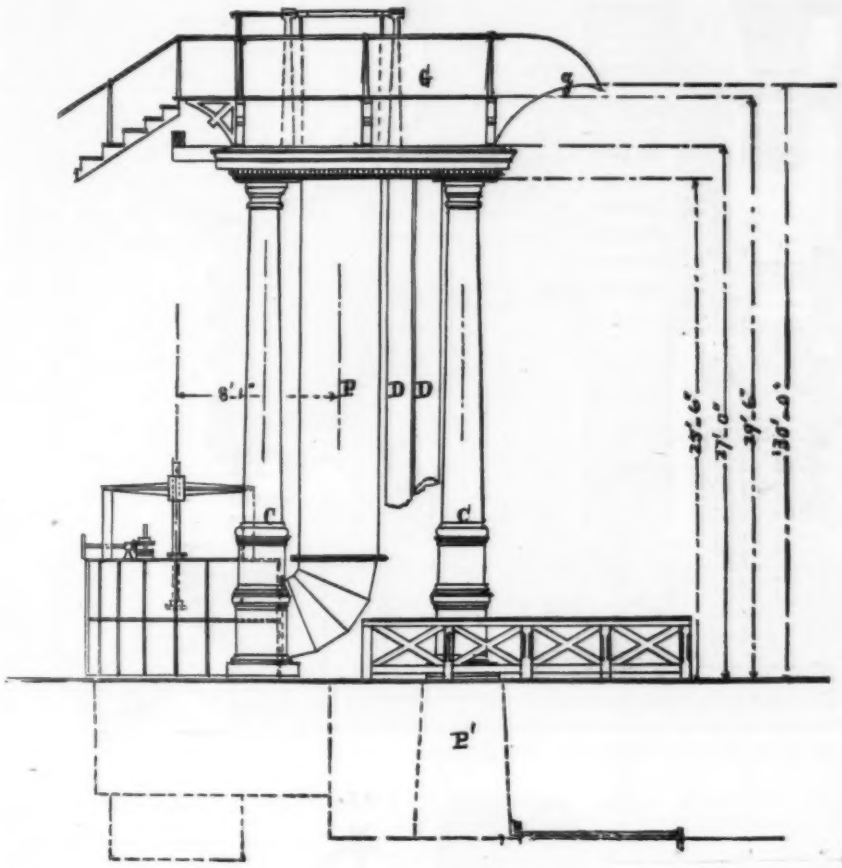


Fig. 6.

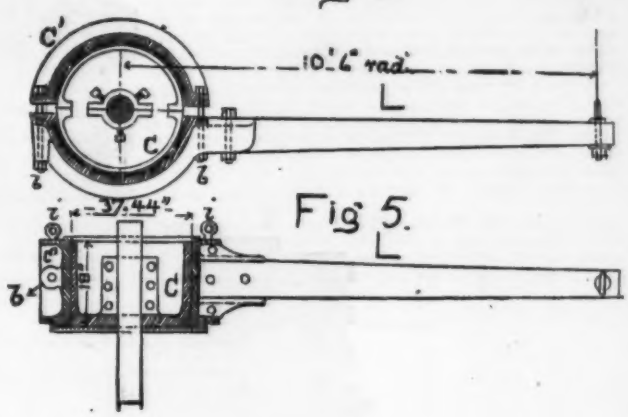
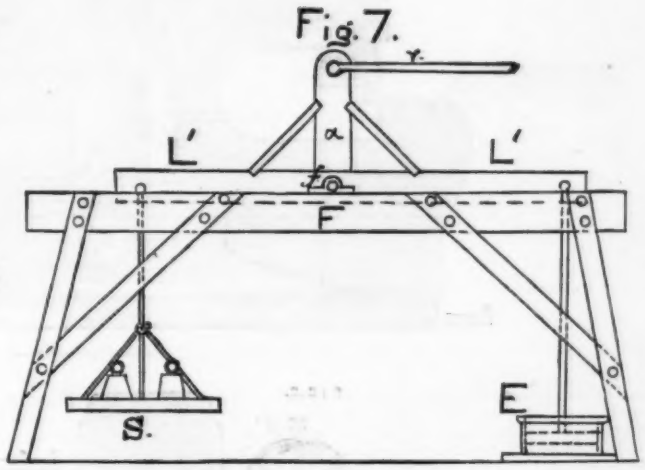


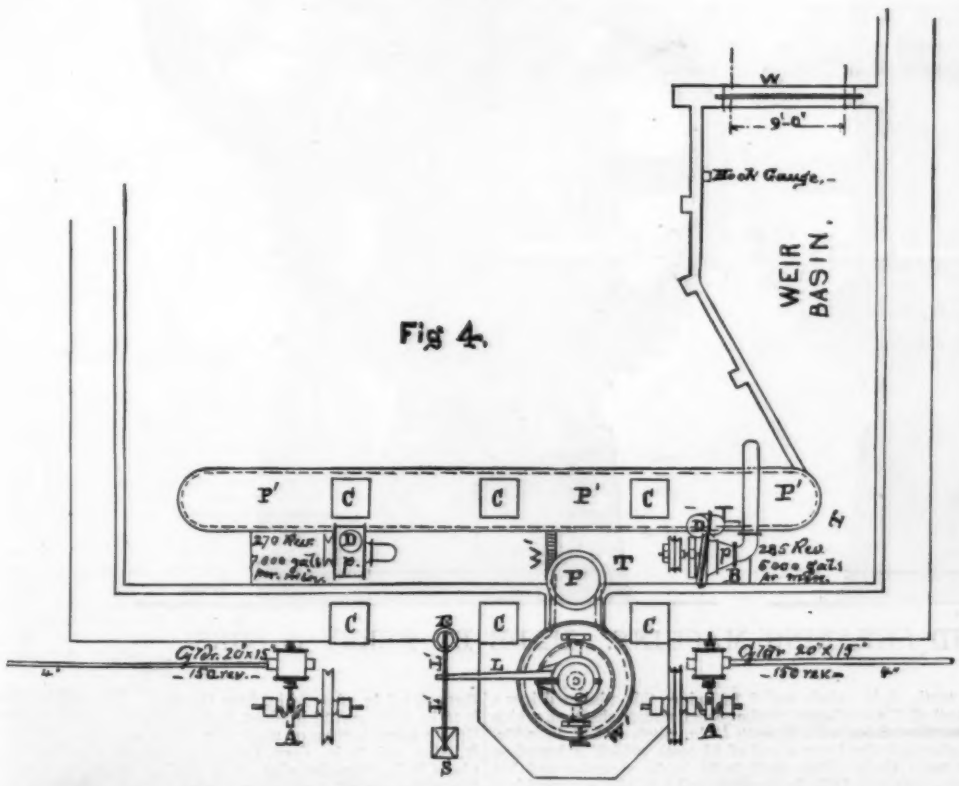
Fig 5.

Fig. 7.



WATER WHEEL TESTS AT THE CENTENNIAL.

Fig 4.



WATER WHEEL TESTS AT THE CENTENNIAL.

A FLY-WHEEL METEORITE.

THE other evening, as the watchman at Albert Dailey & Co.'s lumber yard was sweeping out the office, he was much startled by a blow on the outside of the building, sufficient to shake the building and knock the top from a steam heater sitting near that side of the room. In the morning an examination was made of the building, and it was found that a most terrific blow had been struck by something, and evidently with more than human power. Clapboards and boards were shattered, a beam cut into to the depth of two or three inches, and a pine knot ground almost to powder. It had struck about four feet from the ground and crashed down about two feet, eating its way in deeper all the way till it brought up against the beam. Here was a mystery. What did it? Nothing could be seen in the vicinity that by any possibility had any connection with the blow. Finally an Irishman picked up an object seventy-five feet away, on Dyer street, and exclaimed, "I've found a metheor sure," and unravelled mystery No. 1. This "metheor" proved to be a segment of a fly-wheel, weighing five pounds and a half, with a part of one flange attached. One end of the segment was covered with wood partly pine and partly pine knot, which proved beyond a doubt that this was what struck the building, the wood adhering to it from the force of the blow.

Now came another mystery, and one which for several hours was not unravelled. Where did it come from? None of the establishments in the immediate neighborhood that use machinery had lost anything of the sort, to the knowledge of the proprietors, and they would likely to be aware of it if any such thing had happened, for it would have left its mark when it went away. The force with which it struck, and the distance of its rebound (for it was picked up so early in the morning, 7 o'clock, that there seems little probability of its having been moved since it struck the street), indicated that it must have come with great force, and, naturally, from a great distance. The edge of the flange had the appearance of an old break, but the ends of the segment were bright and fresh.

After hours of wonder the mystery was solved. The mysterious piece of iron came from a wood-sawing shop nearly a quarter of a mile away in a direct line, and was part of a fly-wheel that ran a saw. Tuesday night, just as work for the day was done, and just as the engineer had his hand on the throttle to shut off steam, the wheel broke into small sections and flew in all directions. One piece went through a 4x6 joist, beside the roof, on its way out, cutting the joist in two, and various holes in the roof indicate the different directions the several pieces took.

The wheel was two and a half feet in diameter, and its usual speed was 1,875 revolutions per minute. It is probable it was running at very nearly that speed at the time it broke. The cause of its breaking is unknown. It is wonderful that no one was injured by the explosion.—*Providence (R. I.) Journal*

FIG. 1.

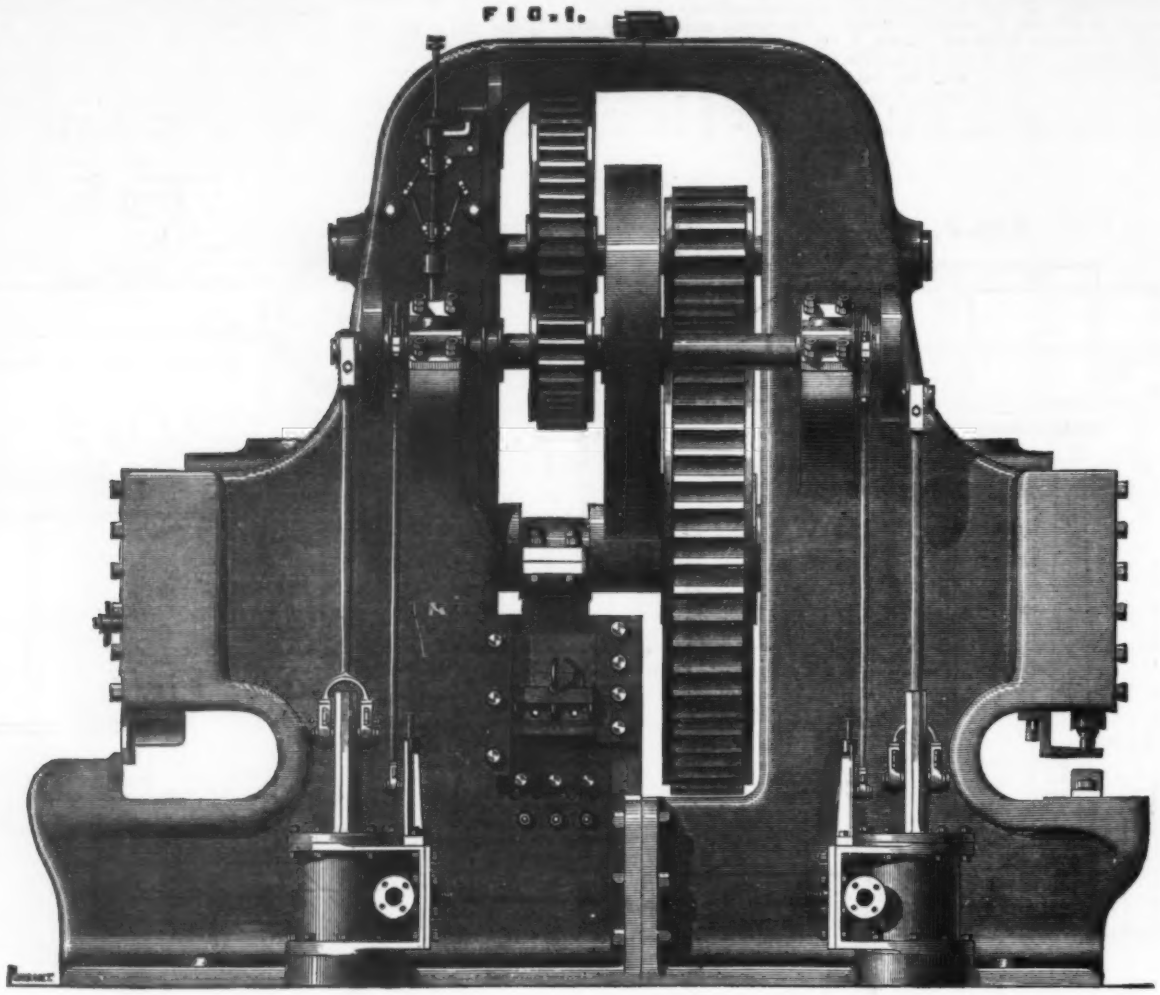


FIG. 2.

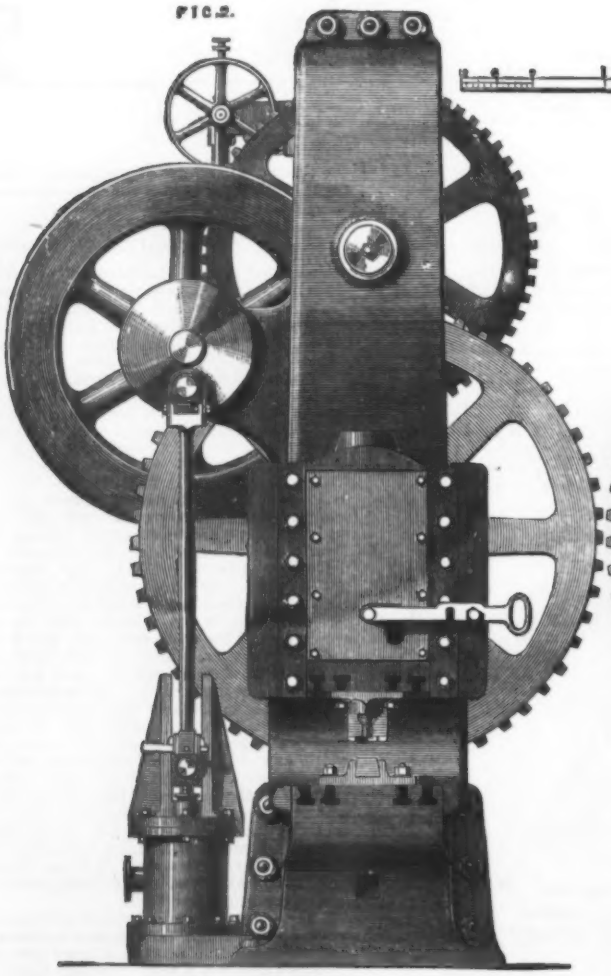
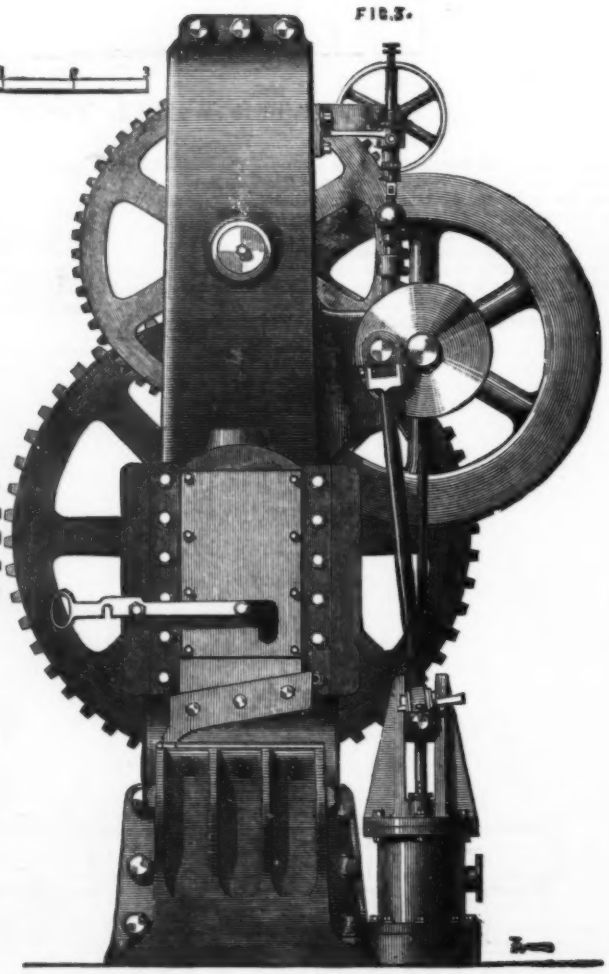


FIG. 3.



HEAVY PUNCHING AND SHEARING MACHINE.' MADE BY BERRY & SONS

PUNCHING AND SHEARING MACHINE.

WE present illustrations of a heavy punching and shearing machine recently constructed by Messrs. Francis Berry & Sons, of Sowerby Bridge, for Messrs. Joseph Wright & Co., Tipton. The machine is of very massive design and weighs 34 tons. It is driven by two engines having cylinders 12 in. in diameter, with a stroke of 14 in. The crankshaft is 5¼ in. in diameter; on this shaft is keyed the first motion pinion of 15 teeth, 3 in. pitch and 8 in. wide; this pinion drives a wheel of 57 teeth keyed on the second motion shaft, on which is another pinion with 13 teeth 4¼ in. pitch and 12 in. wide, gearing into the large wheel of 54 teeth, which is keyed on the main shaft. This shaft is 14 in. in diameter and has three eccentrics 10 in. in diameter and 4 in. throw turned into it, which work the slides. The punching slide is 2 ft. wide and 10 in. deep, and is capable of punching a 2 in. hole through a 2 in. plate 24 in. from the edge. The middle slide is 18 in. wide and 13 in. deep, and is capable of cross cutting the strongest section of steel rails. The end shear slide is 2 ft. wide and 10 in. deep, and is capable of shearing 2 in. plates 24 in. from the edge, or of slitting up old steel rails. The slides are all made of cast steel. Each slide has a disengaging motion, so that the whole machine need not be stopped to adjust a plate.—*Engineering*

THE AUSTRIAN ARSENAL AT POLA.

THE arrangements for repairing vessels consist of a floating dock with an area for four ships; the hydraulic presses for working this are movable and placed on a turning platform. The whole of the Austrian fleet, except a few small vessels, lies in reserve or disarmed at Pola. The workshop is well lighted, arranged and furnished with excellent machines. In the smiths' shops are a number of small American steam hammers. In the sail-making department, sewing machines have been abandoned, and a large number of women are employed for this purpose. The number of workmen employed is 1,500. The stores and their arrangements require special mention. There are three classes: 1. The general depot containing stores required for consumption on board, and for new armaments, or for replacing worn-out *materiel*. 2. Special stores, divided into sections and placed near the shops, containing only materials required therein. 3. Magazines containing all the stores necessary for the ships in reserve or out of commission. The Arsenal of Pola is a true military colony, and is quite independent and apart from the town beside it, and if the former has to a certain extent to depend upon the latter, it seeks to show that it can create and maintain advantages greater than are offered by the municipal authorities. There are found at Pola asylums established and maintained at the cost of the officers, schools belonging to the naval service for the children of officers, employes, etc. The necessity of creating an entirely new town has led to the construction of a large number of houses for the accommodation of officers and men. The former are all in three stories and contain six suites of apartments, varying according to the rank of the officer for whom they are destined: the captain of a frigate, for example, occupies one complete floor, the captain of a corvette five chambers with kitchen, etc. All these apartments are convenient and well arranged.

KRUPP'S PANZERKANONE, OR MASKED GUN.

ONE of the exhibits in Mr. Krupp's noteworthy collection in Machinery Hall, at the Centennial Exhibition, was a full-sized model of a panzerkanone or masked gun. This name is given to the weapon because of an enlargement cast upon its muzzle, which completely fills the port or embrasure, and thus prevents missiles entering the same. The enlargement, as shown at B in the engraving, is spherical in form, so that with the aperture it forms a ball and socket joint.

This construction admits of the gun being trained in any direction, or depressed or elevated by suitably moving the breech, the sphere, as a matter of course, always completely filling the opening. The latter is flared to the rear to facilitate sharp training or extreme elevation. As by this device all recoil is prevented, the carriage need not be so strongly built, and hence may be much lighter than is usual in other guns. The carriage can be raised according to whether the guns are to be used behind stationary walls or movable turrets. Heavy guns are managed by hydraulic machinery, which is placed under the casemate floor. The gun is breech loading and thus can be trained and loaded at the same time.

Mr. Krupp suggests three different dispositions for the invention. First, as a stationary battery. Second, as a movable turret; and in the third, he locates the masked gun on a turn-table behind a half-round breastwork, in which are placed portholes in the form of longitudinal slits.

It has been pertinently suggested that a solid shot striking the wall close to the socket would "jam" the gun in the socket, so that it could not be trained.

THE THIRTY-EIGHT TON GUN—ITS REMARKABLE FORCE.

THE target here shown represents exactly the armor of many of the forts now being erected at Portland, Eng., and along the south, a circumstance which gives a peculiar significance to the results obtained. This is the greatest blow that has yet been delivered against armor, except perhaps a few rounds fired by the same gun against a patched-up structure in the spring. Both on Major Noble's and Captain English's system of reckoning, the projectile could only be expected to penetrate No 40 target if everything were thoroughly excellent and the firing well carried out. No. 40 target consists of the following layers, shown in our engraving: 6½ in. plate, 5 in. of teak; another 6½ in. plate; a second 5 in. of teak; and lastly, a 6½ in. plate; thus making a total of 19½ in. of plate and 10 in. of teak. The plates were held together by Palliser 3 in. bolts coupling each to the one next behind it; that is to say each bolt passed through two plates. The bolts were made with the ball and socket shoulder, and the usual provision in the way of play to prevent shearing. The plates were supplied by Brown. Each plate was 10 ft. by 8 ft., eight bolts being passed through the front plate. The gun was mounted at 70 yards range, and fired a charge of 180 lbs. of pebble powder of 1 in. cube. The projectile weighed 812 lb., including 11 lb. 3 oz. for the copper gas check. The projectiles were taken out of the regular service supply at the battery.

The first round was a trial one for range and accuracy, directed against a 10 in. plate, erected with strong wooden supports, about 7 ft. in front of an old target. The projectile, of course, penetrated the 10 in. plate, but being slightly deflected as it traversed the air space behind, struck the old target irregularly, and so shivered itself to pieces. Any person not familiar with the subject would have supposed that the pieces of iron picked out of the front of a target without difficulty after impact could not be of strong quality. How false an impression this would have been would have been discovered when the second round was fired. This was delivered on a spot 2 ft. 8 in. from the bottom and 3 ft. from one end of the new target on apparently a strong, sound part. The penetration obtained may be seen in the engraving. The head and body of the projectile passed entirely through the whole target and backing, breaking up, as shown in the cut, on the far side. The hole was a very clean cut one; the base of the shell was left wedged in the target—*vide* cut. The gas check and base plug were broken to pieces. The front portion of the shell stood up to the work admirably, and the penetration was more than could have been looked for. The striking velocity was 1,420 ft. a second. The head of the projectile became detached, the point being polished by its work in penetration, but not broken in the least degree. The target plates stood admirably, the bolts were not started, nor was much injury done to supports or any part of the structure except the clean hole made by the shot. The iron plates were of excellent quality.

The 38-ton gun thus achieved a great success at Shoeburyness when it drove its projectile through 19½ in. of excellent iron, and 10 in. of teak. The gun factories may well be proud of their gun, and still more perhaps may the Laboratory be congratulated upon their projectile. The experiment was a beautiful one. The preliminary round, in which a similar projectile, after passing one plate, was incidentally caused to strike a second target in an indirect position, that is to say, not quite point first, showed how easily the same metal which penetrates wonderfully when directly applied, may be shivered under other conditions. It showed, in fact, how well the projectiles of hard chilled iron are turned to account in Palliser projectiles. All this is very satisfactory to the manufacturing department, and in this light has the experiment been dwelt upon by those who have discussed it. Nevertheless, the question remains whether there is not another side to be considered. If the gun has overcome the target, are we so entirely interested in the destructive powers of guns, and so little interested in defensive armor, that this result is unmixed good to us? The truth is, that while the proof of the excellence of our Woolwich system of guns or our particular form of chilled projectiles is satisfactory, a good deal of expense and inconvenience is entailed by the fact that the armor in question succumbed so completely. "No. 40 target," as it is called, is the exact sample of the armor of many of our coast forts, consequently we now learn that if we wish them to be proof against even pieces equivalent in power to the 38-ton gun, we must strengthen them considerably. In other words, we may have to expend many hundred thousand pounds in making our forts as strong as many fondly hoped them to be already. This experiment, then, brings before us the whole question of the defence of our harbors and rivers.—*The Engineer*.

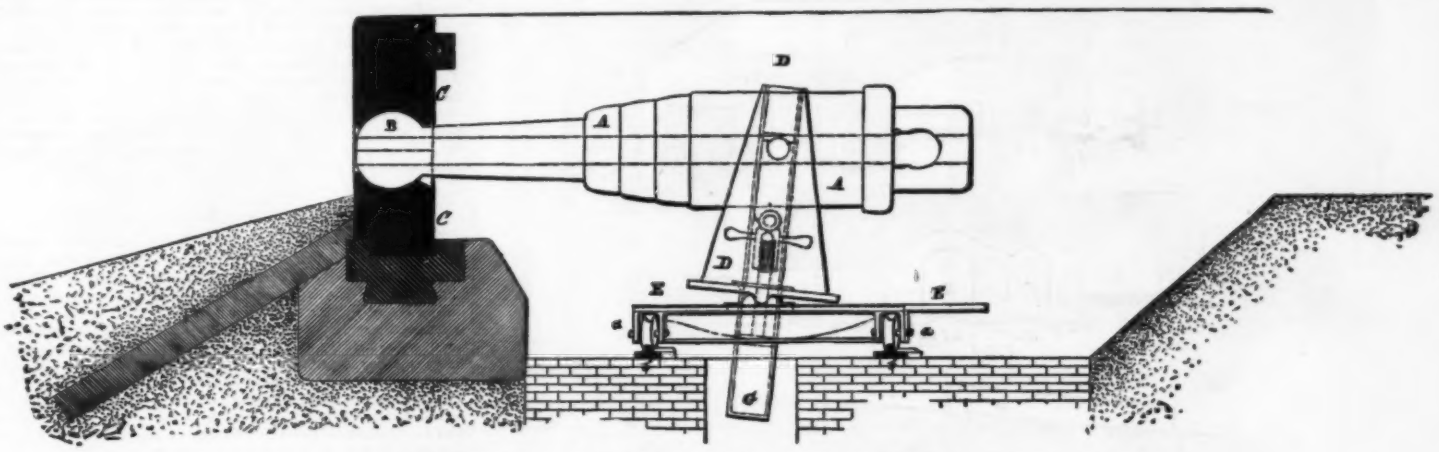
RECENT ARTILLERY AND ENGINEERING EXPERIMENTS.

A SERIES of experiments have been in progress for some time past at Eastbourne, England, with the object of testing the power of the siege guns of the present date against the engineer works that would be constructed to resist them. It must be observed that these are not works of permanent fortifications, although they might easily be mistaken for them, but structures made with railway iron, timbers, and concrete, such as might be constructed during a siege of any ordinary length, or to meet an attack of which there was a few days' notice, supposing the stores to be at hand, which, in the present state of modern warfare, is not an unreasonable supposition. The practice must necessarily occupy several weeks; we have not, therefore, attempted to notice the results obtained until such progress had been made as enabled something more to be said than the mere summary of the rounds fired on a few days.

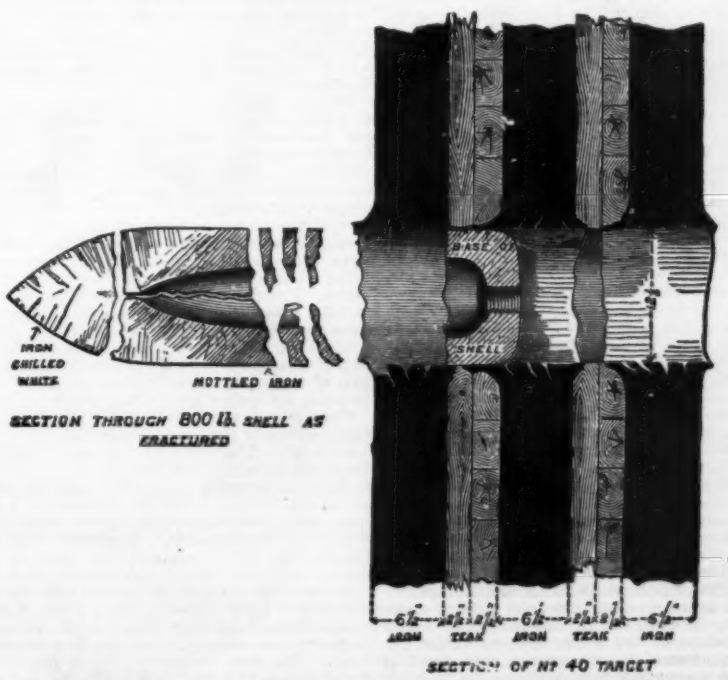
The programme put forth by the Special Committee of Engineers and Artillery Officers is as follows:—The points on which information is sought are: (1) The effect of heavy projectiles fired at long ranges falling at high angles on casemates of various kinds; (2) the effect of grazing, curved, and direct fire at comparatively short ranges on the roofs of casemates; (3) the effect of projectiles striking the overhanging portion of the interior of a Moncrieff pit; (4) the effect of projectiles on field, splinter, and bombproofs of various types; (5) the effect of artillery fire against siege batteries of various types; (6) the powers of a special "over-bank" carriage for a 64-pounder gun; (7) the behavior of the 8 in. rifled howitzer on a carriage working on an Alderson platform with a special directing bar; (8) the qualities of various platforms and special arrangements connected with them; (9) the breaching powers of some new battering projectiles for the 64-pounder gun.

In order to carry out these experiments a block of casemated works has been constructed with a Moncrieff pit in rear (*vide* Figs. 1, 2, 3, and 4). To the left front of the casemates has been constructed a siege battery for two guns of the latest type. In rear of the casemated battery is the old target battery used in the previous trial, which has been repaired and put in order to exhibit the effect of any shot that may miss the casemates and strike this work.

The ranges are as follows: 1,500 yards from C battery near martello tower on Anthony's Hill; 3,000 yards from glacis of Eastbourne redoubt. The ordnance to be employed are 10 in. howitzer, 8 in. howitzer, 6·3 in. howitzer, and 64-pounder



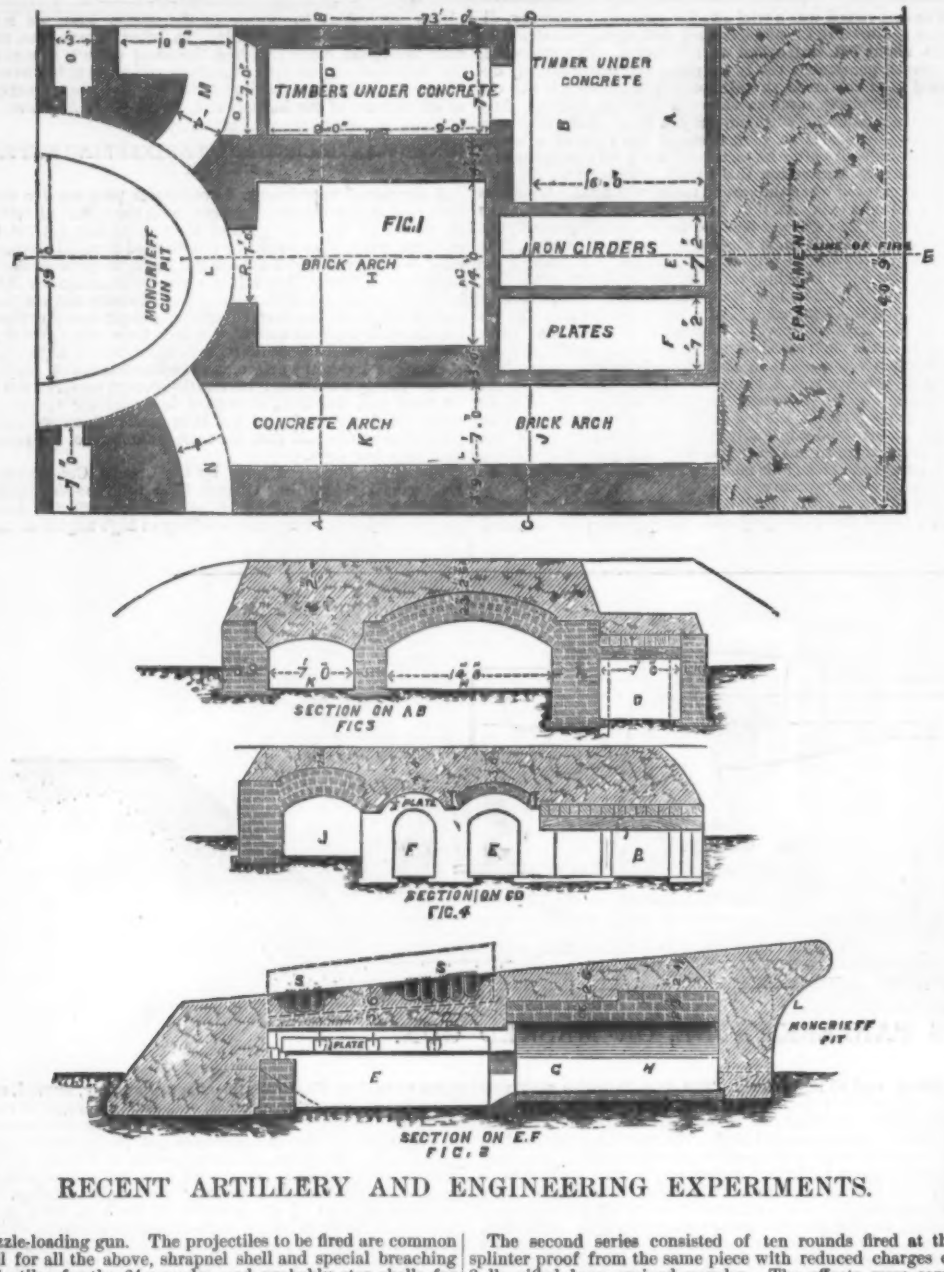
KRUPP'S PANZERKANONE, OR MASKED GUN.



SECTION THROUGH 800 lb. SHELL AS FRACTURED

SECTION OF Nº 40 TARGET

REMARKABLE TARGET PRACTICE WITH THE THIRTY-EIGHT TON GUN.



RECENT ARTILLERY AND ENGINEERING EXPERIMENTS.

muzzle-loading gun. The projectiles to be fired are common shell for all the above, shrapnel shell and special breaching projectiles for the 64-pounder, and probably star shells for the 8 in. howitzer.

Platforms.—Clark's ground platform modified, and a special platform for the 10 in. howitzer improvised from an octagon S S mortar bed. Wheel chocks and other arrangements for neutralizing recoil adapted to a modified Alderson's platform for 8 in. howitzer.

Order to be followed.—(1) Firing from C with 8 in. and 6·3 in. howitzers, also 64-pounders; eight rounds from each at exterior slope of casemated parapet. (2) Ten rounds from each of above as grazing fire on superior slope of casemate. (3) Firing at casemate from glacis of Eastbourne redoubt at 3,000 yards with 10 in. howitzer, with an elevation to give an angle of descent of 50 deg. (4) Firing with new projectiles at dismantled martello tower.

Figs 1, 2, 3, and 4 show the casemated structure fired at, Fig. 1 being a horizontal section, Fig. 2 the section along the line of fire, Figs. 3 and 4 sections across the line of fire or along the parapet. The various casemated chambers are as follows: A—*vide* Fig. 1—has a roof of 12 in. by 12 in. baulks, with 2 ft. of concrete over it, 16 ft. open. B the same, but with 3 ft. 8 in. to 4 ft. 4 in. of concrete on the top—*vide* Figs. 1 and 4. C the same, but 9 ft. span, with from 4 ft. 6 in. to 5 ft. 3 in. of concrete on it. D the same, with 2 ft. of concrete on the top. E ½ in. iron arch plate 7 ft. 2 in. span, on iron girders 18 ft. span, with 13½ in. of brickwork, and 2 ft. to 3 ft. of concrete on the top. F the same, with from 3 ft. 2 in. to 4 ft. 8 in. concrete. G brick arch 1 ft. 6 in. thick, 14 ft. span, and from 1 ft. 7 in. to 2 ft. 4½ in. concrete at top. H the same, 2 ft. 3 in. thick, with from 1 ft. 7½ in. to 2 ft. 6 in. concrete. I the same, 7 ft. span, with 1 ft. 6 in. of brick and from 1 ft. 5½ in. to 2 ft. 4 in. of concrete. J the same, with brick work 2 ft. 3 in. thick, and from 1 ft. 7 in. to 2 ft. 5½ in. concrete. K concrete arch, from 4 ft. 7 in. to 6 ft. 2 in. concrete. L semicircular arch, concrete from 3 ft. 8 in. to 7 ft. 11 in. at springing of arch. M passage under concrete 5 ft. thick, spans 10 ft. and 4 ft. N concrete arch 4 ft span, and 4 ft. of concrete on the top. O resembles M, but with only a 3 ft. span. P resembles N, but with 3 ft. span. Q flat concrete, span 7 ft. wide, 6 ft. of concrete on top. R concrete 7 ft. span, and 4 ft. 6 in. concrete.

The more important results are as follows:

In October, 1876, the firing was from "C" Battery, near the Eastbourne and Pevensey road, 1,500 yards range, from the concrete work above described. Ten rounds were fired from the 6·3 in. howitzer with a charge of 4 lb. rifled long-grained powder, weight of shell 65 lb., bursting charge about 7 lb. This was tolerably direct firing. The results produced were about 4 ft. of concrete struck off one lower corner of the exterior slope of the work, a scoop or groove of 3 in. deep made in the superior slope, and a large crater 5 ft. across made in the earth and gabions—shown in Fig. 2—in the superior slope of the work, and one gabion dislodged. The comparison of this crater with corresponding effects produced in the concrete portion shows the resisting power of the latter.

The second series consisted of ten rounds fired at the splinter proof from the same piece with reduced charges of 3 lb. rifled long grained powder. The effects were some timber started under the work, the damage to the left corner of the work increased, and a crater made in the exterior concrete slope of 2 ft. 6 in. deep and 3 ft. 6 in. across. The concrete of superior slope was again scooped out in a groove 2 in. to 3 in. deep. Four rounds were also fired from the 64-pounder gun.

The same pieces of ordnance fired shells plugged with sand, from the same range, against the work, to see if they would break up against the concrete. The 64-pounder fired with 10 lb. charge and 2° 15′ elevation. No great damage was done to the work. Grooves were cut in the superior slope a few inches deep, the shell bounding, apparently unsplit, to sea. One shell struck the exterior slope and rebounded uninjured except its studs. The 6·3 in. howitzer, with 4 lb. charge, behaved in as similar a manner as possible. One crater was made in the exterior slope 1 ft. deep, the shell rebounding 4 ft. back, which crater was enlarged by a subsequent round to 17 in. depth, the width at top being 5 ft. 6 in. by 4 ft. 6 in. The corner of the casement was further demolished.

Practice was carried on against a ruined martello tower at 1,040 yards range. The gun was fired off the road without platform, the recoil being checked by wood chock-blocks. The object of the firing was to test the shells more fully by firing them against more solid masonry work than the casemates. The 64-pounder gun fired common shells plugged with sand for five rounds with 10 lb charge, and carried away large portions of the work. Long battering shells, 90 lb. full weight were next employed. Five rounds were fired empty, weighing in that condition 86 lb., the firing charge being 12 lb. Still greater effects were produced. Practice with filled shells followed, the work being rapidly demolished. One peculiar projectile was tried, namely, a shell that had been cast with a solid and sharp-pointed head like that of a Palliser projectile. The penetration of this was about 7 ft., being considerably greater than that of the common shell, which is about 4 ft., the latter breaking up against very solid portions of the structure.

The 6·3 in. howitzer was fired at high angles and with low charges against the concrete casemate, etc. The range was 1,400 yards. The effect of eighteen rounds was to make large craters in the earth, and in one case 6 ft. deep and 12 ft. wide, and small grooves, etc., in the concrete. Next five rounds were fired with the 64-pounder; a comparatively large crater was made in the exterior slope of concrete from 8 ft. to 12 ft. in diameter. Experimental percussion fuzes, supplied by the Laboratory, were tried in some of these shells, the object being to ascertain the best time after impact for the bursting of the shell to take place. Fuzes have before now been rendered more quick and sensitive by using a thinner covering over the percussion powder than formerly—for example, paper has been substituted for sheet brass. The fuzes at present being tried have safety pins which escape by centrifugal force due to the rotations of the shell. They have the usual cushion of lead to prevent danger of rebound behind the pellet, and a thimble has been used over the head of pellet and needle to prevent the entrance of foreign matter and the choking of the fuze.

The 8 in. howitzer was fired at high angles from the C battery, near the Langley or Eastbourne and Pevensey road. Shells were fired with and without bursting charges. The exterior slope or epaulments of the casemates was further damaged, and some very good shooting was made, the Moncrieff gun being struck by a blind shell, which grazed the edge of the parapet, and afterwards smashed up by a shell which burst and "killed" three or four dummies, as well as cutting the crest of the parapet and disabling the gun and carriage. The firing was at various elevations, up to 15 deg.

The following results were then obtained against the splinter-proof portion: seven iron rails were snapped and baulks of timber started in adjoining section, but no actual opening was effected. With time-fuzes some further damage was done to timber supports, and more craters made. Two blind shells were fired at the work.

The 8 in. howitzer was fired at the casemate at 34 deg. of elevation with live shell containing a bursting charge of 14¼ lb. of powder, with experimental sensitive fuzes, the firing charge being 3lb. The shells thus thrown fell short until the elevation was increased to 38 deg. At the eighth round the shell fell on the part of the casemate—E in Figs. 1 and 2—behind the epaulment, where the concrete is supported on iron girders and plates, causing fracture of supports and loosening of interior. No other more important effects than an increase of the damage to the epaulment and surfaces of concrete was effected. The 8 in. howitzer was afterwards fired to test recoil against chock-blocks, consisting of large curved wedges on whose surfaces the wheels recoil. When fired with a 10 lb. firing charge the gun recoiled right over them, but they were effectual with smaller charges. The effects on the casemate by the firing this afternoon were—Moncrieff gun carriage and gunners further injured by the bursting of a shell, and the face of the epaulment or exterior slope of parapet further broken, the whole surface of the exterior slope being now broken up, but the concrete lying nearly in its place, and still acting as a protection to the casemates in rear.—*The Engineer.*

THE GREAT SUSPENSION BRIDGE.

THE great suspension bridge over the East River, between the cities New York and Brooklyn, 1,600 feet span, is progressing as rapidly as circumstances will permit. The preparations for the wearing of the great cables is now going on. Five of the ten "cradles" or platforms upon which the workmen are to stand while laying the cables, have lately been successfully placed in position. The cradles are 48 feet long and about 5 feet wide, and are placed on the cables transversely, that is to say, parallel with the river. Of the five now in position, three are over the river, one in the center, and the others at equidistant points between the center and the towers. The other two are placed at points between the anchorages and the towers. Should the weather be favorable, the remaining five cradles will be put in their places within a week. They will not be placed at different points, but alongside, or end to end with the others, at a distance of about four feet, and will be connected with each other by means of a bridge platform of strong timber, thus making a continuous platform of about 100 feet long, the whole resting on the three cradle cables and one of the foot bridge cables. Access to these will be obtained by the foot-bridge, which will extend from anchorage to anchorage. The construction of this bridge has already been begun on both sides of the river, and about 350 feet have been completed at each anchorage. When built over the river, this bridge will be made perfectly steady by means of the storm cables, with which it will be connected by wire ropes about three-eighths of an inch in diameter.

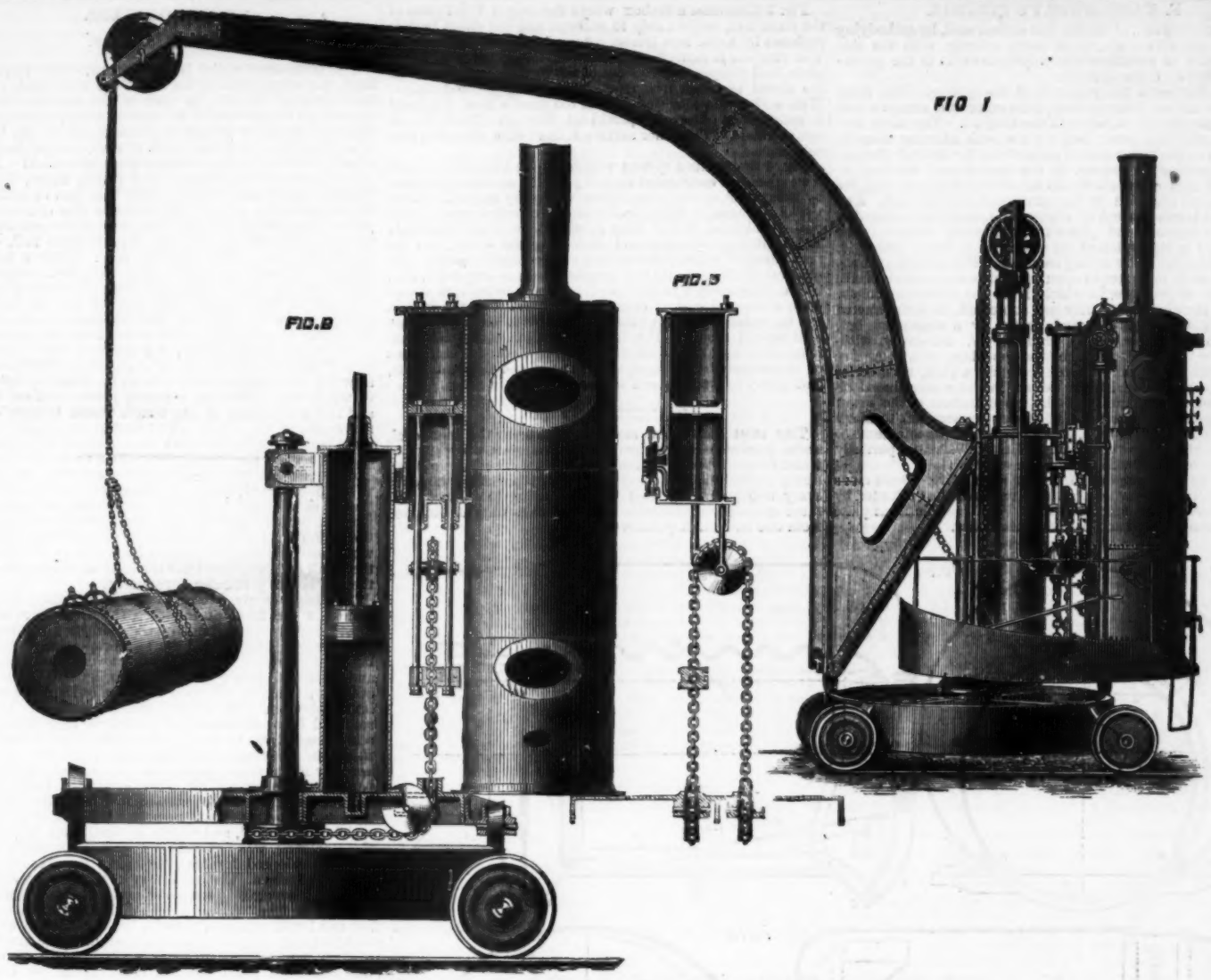
Besides the cables already mentioned, there are now three "pendant" cables (to which will be added a fourth) which will hang directly over the centers of the great cable. When the work of laying the great cable is begun, small iron rods with leaden weights at the ends will be suspended immediately above the cradles, and will be used to keep the wires apart while being laid in the strands. The great cable will be composed of 19 of these strands, which will contain about 330 wires each. When all the strands are completed, the temporary fastenings will be removed and they will all be placed together to form the great cable, which will then contain about 6,000 wires. The wires, which will be of galvanized steel, will be a little over one-eighth of an inch in diameter, and will receive two coatings of linseed-oil before being used for the cables.

The operation of placing the cradles in position was a hazardous one, and was watched with great interest by crowds of persons on both sides of the river and on the ferry boats, and much admiration was expressed at the skill and daring of the workmen. They, however, did not seem to think that they were in any peril, and did their work as quietly and unconcernedly as if they had been on the ground and not standing on a rope at the height of 200 feet above its surface. Some of the cradles are now slightly deflected to the right, as seen from the New York side, but Mr. Farrington, the master mechanic in charge, says that when the foot-bridge is completed, its weight will draw the cables to the proper position, and the platforms will then be on a level.

BROWN BROTHERS' PORTABLE STEAM CRANE.

IN this crane pressure is brought to bear directly on a piston with a stroke of some 6 ft. The rod of this piston carries two or more sheaves in the crosshead at the top, and round those sheaves pass the bights of the hoisting chain, one end of which is fixed to the crosshead. The result is that the piston stroke of 6 ft. is multiplied into a chain stroke of 12 ft. to 24 ft., according to the number of doubles or bights in the chain. Cranes of this kind were used very successfully during the building of Blackfriars Bridge, and from time to time they have undergone improvements. We illustrate above one of the latest type, constructed by Messrs. Brown Brothers, of Glasgow and Cannon street, London.

From what we have said, no difficulty will be experienced in comprehending its construction and mode of action. The large hoisting cylinder is shown in section in the detail drawing, Fig. 2, while Fig. 3 is a detail of the arrangement for swinging the crane. In order to place the whole under complete control, a very ingenious hydraulic controlling gear is employed, the pipes, etc., of which are shown in Fig. 1 between the hoisting cylinder and the boiler. The jib is of wrought iron, and the boiler and machinery make a very effective counterbalance. These cranes work steadily, swiftly and economically, and they are specially applicable to the hoisting at frequent intervals of moderate weights—say a



BROWN BROTHERS' PORTABLE STEAM CRANE.

couple of tons—as, for example, in warehouses and quarries. There is no wheel gearing to break, and the arrangements are too simple to readily get out of order.—*The Engineer.*

WEST'S SIX-CYLINDERED STEAM ENGINE.

AT the recent Smithfield Club Show, several multiple cylinder engines were exhibited, one of these being the 6-cylinder engine made by Messrs. Plambeck & Darkin, West's patent, of which we give illustrations. Fig. 1 shows the outward appearance of the engine. The spring governor is enclosed in a hollow drum on the driving shaft, the drum working to and fro and actuating the throttle valve by means of a lever as shown. Figs. 2, 3, and 4 are longitudinal and transverse sections. The body of the engine consists of one casting, containing six cylinders arranged in a circle and having parallel axles. The pistons A A bear continuously against a conical disk, B, and are single acting, steam being admitted

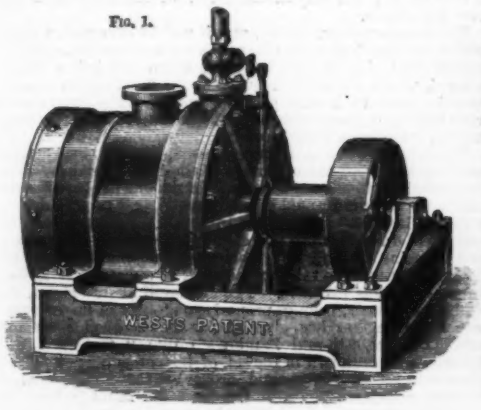


Fig. 1.

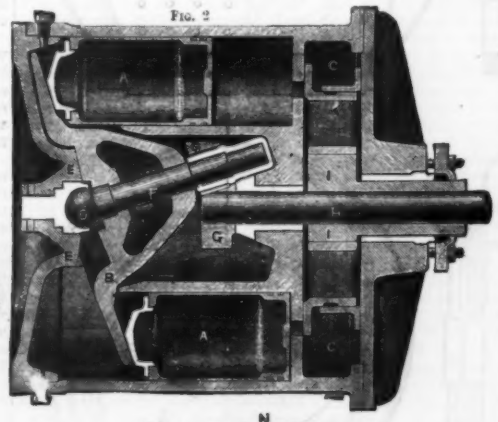


Fig. 2

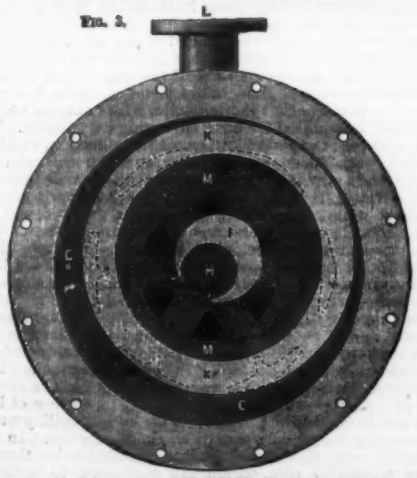


Fig. 3.

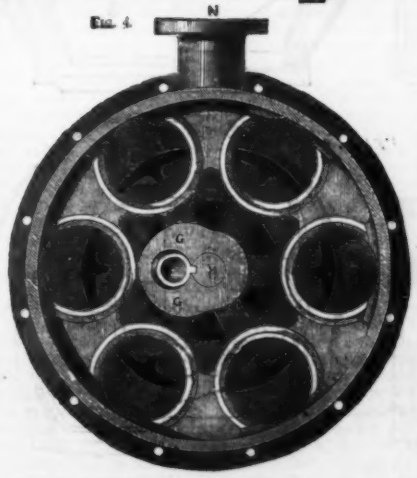


Fig. 4.

WEST'S SIX-CYLINDERED STEAM ENGINE.

to the flat ends only, and successively to the six cylinders from the steam chest C, three pistons being constantly in action at different points of their strokes, thereby imparting a uniform rolling motion to the disk B. The latter is supported at its center by the ball joint D, and also rolls upon the conical surface of the back plate E. The crank pin F is fixed in the center of the conical disk B, the rolling motion of the disk causing the pin to describe a circle around the shaft H, and thus imparting a rotary motion to the latter by means of the crank G. The shaft H passes through the center of the steam chest C, and carries an eccentric I, giving motion to an annular valve. The ports are arranged in a circle. The valve consists of two flanged rings, one fitting over the other, the opposite flanges being forced asunder by the pressure of the steam, the one against the port faces, and the other against the steam chest cover. These are large rubbing surfaces causing friction dependent upon the steam pressure, but the ring valve is in equilibrium as far as the steam pressure on its circumference is concerned. The steam enters the space outside the circumference of the valve ring K, the eccentric motion of which opens and closes all the steam ports successively; from these the exhaust escapes into the chamber M inside the valve ring, and thence, through openings into the body of engine, into the exhaust pipe N. Fig. 4 is a view of the interior of the engine with the back cover taken off and the disk and pistons removed, showing the position of the steam ports and exhaust passages, the exhaust pipe N, and the crank G. All the working parts are lubricated by the steam charged with oil from a lubricator on the steam pipe. The engine is usually constructed to cut off steam at half stroke, but the cut off may be varied by altering the position of the eccentric. The engine may be constructed with variable expansion gear and as a condensing engine. The engine is very compact, has no steam passages, and, we are informed, gives off 90 per cent. useful effect.—*The Engineer*

PETROLEUM.

THE formation of petroleum has been explained by Mr. B. Byasson upon experimental grounds, as follows: If a mixture of vapor of water, carbonic acid, and sulphuretted hydrogen be made to act upon iron heated to a white heat in an iron tube, a certain quantity of liquid carburets will be formed. This mixture of carburets is comparable to petroleum. The formation of petroleum can thus be naturally explained by the action of chemical forces. The water of the sea, penetrating into the cavities of the terrestrial crust, carries with it numerous materials, and especially marine limestone. If the subterranean cavity permits these new products to penetrate to a depth where the temperature is sufficiently high, in contact with metallic substances, such as iron or its sulphurets, we have a formation of carburets. These bodies will form part of the gases whose expansive force causes earthquakes, volcanic eruptions, etc. Petroleum is always found in the neighborhood of volcanic regions or along mountain chains. In general it will be modified in its properties by causes acting after its formation, such as partial distillation, etc. Petroleum deposits will always be accompanied by salt water or rock salt. Often, and especially where the deposit is among hard and compact rocks, it will be accompanied by gas, such as hydrogen, sulphuretted hydrogen, carbonic acid, etc.

E. KASELOWSKY'S FIREBOX.

Mr. KASELOWSKY, of Berlin, has endeavored, by embodying previous improvements, to do away entirely with the side stays, which he considers the only drawbacks to the perfection of the two latter systems.

Fig. 1 illustrates the principle of his system. The inner firebox is entirely independent of the outer one, except where the two are riveted together at the ring *e e*. The inner firebox *a a*, and the outer one *c c*, are both circular shaped, eccentric to the boiler and to each other, for several obvious reasons, *inter alia*, because, by the insertion of the ring *e e*, the inner and outer shells can be riveted together, and the space to be occupied by the grate cut entirely out. The inner box is constructed of copper, diagonally corrugated to add to its stiffness, and give a better heating surface. The outer box is strengthened by means of a small girder *f f*, bolted to the boiler by strong stays *g g*. The tendency of the plates of both fireboxes to open outwards on account of the inequality of pressure, to which, from the difference in the area of their surfaces, they are subjected, is counteracted partly by the ring, *e e*, and partly by a clamping bar, *s*, across the center. The firebars, *i i*, are easily withdrawn or renewed through the opening, *e e*. A fire bridge, *k*, which may be of firebrick, a pipe, or a series of pipes connected with the boiler, has been introduced on account of the proximity of the grate surface to the lower rows of tubes; behind it a small space has been left to allow ashes, etc., to fall through, and a current of air to ascend to assist in consuming the smoke. What effect will a partially cold blast have towards cooling the tubes?

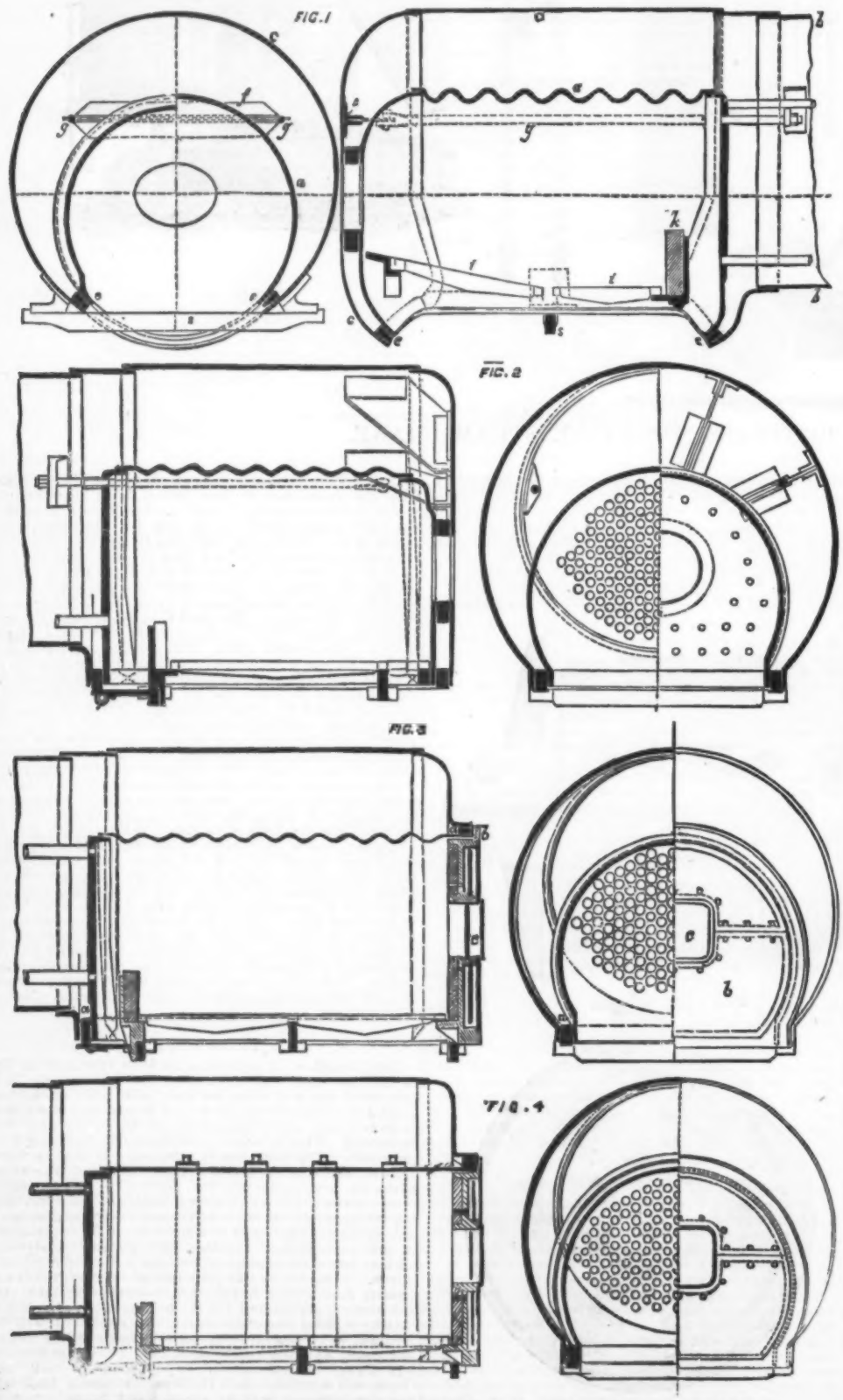
Fig. 2 shows a proposed form for locomotives where more space for the different equipment is required than afforded by a firebox as much rounded off as in Fig. 1. The front plate is here strengthened and bolted to the boiler.

Fig. 3 illustrates a firebox where the copper front plate of the inner box, subject only to radiated and not direct heat, is replaced by a cast iron frame, containing fire doors, etc., etc. The ring *a a* is carried in a circular form round the front plate, and compasses two sides of the inner box, whose ends are closed by a cast iron front, *b b*, holding the firedoor, *c c*. With a view to protection against too great a heat, this front is constructed of several partitions, through which the air can circulate. The inner surface is lined with some fireproof substance.

Fig. 4 represents a system which can be adopted to avoid the expense of corrugated copper plates in stationary boilers, by using steel or iron plates strengthened by rings of ⊥ iron.

The advantages claimed for these several forms of fireboxes, which are in fact mere modifications of one principle, are: facility of cleaning and inspecting the boiler, and the prevention of boiler stone settling on inaccessible parts. The removal of all obstacles to expansion, such as stay-bolts, etc., and consequently a reduction of tendency to rupture at corners; decreased cost of erection and repairs, as the firebox can be replaced without difficulty, and with less expenditure of time and money. For the introduction of the cast iron front plate, special advantages are claimed, such as cheapness of construction and repairs, rigidity of the different parts, and safety in working.—*The Engineer.*

THE most economical steam boilers, using the least coal, under favorable circumstances, will evaporate ten pounds of water for each pound of fuel consumed. The best ordinary steam engines and boilers yield one horse power per hour for every two pounds of coal burned during that time. But there are some examples where the same duty is obtained from one and a half pounds of coal.



FIREBOXES FOR TUBULAR BOILERS WITHOUT STAYS.

THERMOMETERS.

By Dr. R. J. MANN.

THE instrument which is almost universally employed to mark the temperature of the air is the mercurial, or spirit, thermometer. Mercury is used in the construction of this instrument on account of the facility with which it contracts and expands under change of temperature, of the largeness of its expansion on the addition of heat, and of the fact that it only solidifies in very extreme degrees of cold. Between the temperatures of freezing and boiling water, this liquid expands rather more than one fifty-fifth part of its bulk. In the construction of the thermometer this circumstance is turned to practical account by enclosing the mercury, which has to expand and contract, in a hollow glass ball, or bulb, continued above into a narrow tube. With a bulb fourtenths of an inch in diameter it is easy to arrange a tube which shall be filled to a length of several inches, by a fifty-fifth part of the mercury that can be held in the interior cavity. In order, however, that this simple instrument may be capable of giving the exact indications that are required for the purposes of science, it is essential that the bore of the tube should be of even size throughout, that the points in it at which the mercury will stand at the freezing and boiling of water should be very carefully ascertained and marked, and that every trace of air which would hamper the free movement of the liquid metal should be expelled. When these several conditions have been secured with the utmost attainable care, the instrument is held to be of "standard" excellence. But other thermometers can then be compared with this standard, and so be made of scarcely inferior authority as instruments of close observation, when their comparative performance has been thus ascertained. In the Loan Collection Exhibition, London, the fine series of instruments which are contained in the first large case of the Room L, at the south end, well illustrate the skill of the best makers of the day in this particular department.

Two instruments, one by Casella, No. 2,826*g*, and one by Elliot, on the front of the case, show the form which the most carefully made standard thermometers assume. Both have elongated bulbs, and the best proportions of column to bulb for ensuring quick response to changed temperature, and sufficient length of indication in the column. The scales are indelibly cut upon the glass of the tubes, as is now invariably done with all the best instruments. In Elliot's standard these divisions are carried to half degrees. The scale ranges from 15° to 125° of Fahrenheit. In both instruments the tubes have been carefully tested for accuracy of bore, by measuring a small fixed quantity of mercury in all parts of the tubes, and the tubes have then been filled, and left for some months to consolidate their glass, before the process of graduation was performed. The Fahrenheit scale, which is employed, and which is used with most English thermometers, was devised by Gabriel Fahrenheit, of Dantzic, who adopted for his zero points the greatest cold observed in Iceland. The advantage of this scale, which makes it retain a strong hold upon the favor of English meteorologists, is the great number of the divisions between the boiling and freezing points, namely, 180, and the convenient fact that no minus quantities are touched until the unusual cold of 32 degrees below freezing is reached. All registers above this depressed point are therefore noted by continuous ascending numbers, from 1 to 212, the 32 in this series then corresponding with the consolidation of water.

SENSITIVE THERMOMETERS.

Close by these standard thermometers is one very remarkable instrument by Negretti and Zambra, which is probably the most sensitive thermometer that has ever been made. Its mercury reservoir has the form of a gridiron of eight bars, instead of the more ordinary one of a bulb, and takes up its change of temperature almost on the instant. The tube, with its gridiron reservoir, is a surprising specimen of the glass-blower's skill; the construction of the instrument was, however found to involve so much difficulty that this specimen is unique; it is the only thermometer of the form that has ever been made.

The thermometers, 2,827*a*, are, it will be observed, a pair, which are identical in all other points excepting that one has half of the inside of the glass tube converted into a white enamel, which shows the movement of a fine column of mercury in front of it with great clearness. This illustrates a very important improvement in the construction of thermometers, which was introduced by Negretti and Zambra.

The Board of Trade thermometers, 2,827*e*, also by Negretti and Zambra, show the extension of the same principle to the construction of the outer scale. In the one of these instruments the scale is formed of white metal, and rapidly deteriorates in legibility from use. In the other instrument the scale is of durable white porcelain, with indelible black lines, and remains untarnished under any amount of exposure. There is one excellent thermometer, of a bold and very legible form, by Elliott Brothers. The Pastorelli thermometer, on white metal scale, belongs properly to a series of instruments which this maker has planned for the use of colleges and schools. Negretti and Zambra's ordinary meteorological thermometer is shown in the set of instruments adopted for observatories of the second order by the Meteorological Society, which are placed in the observing frame in front of the first window. Analogous instruments by Casella are exhibited in the shipboard frame of the Meteorological office in the third case from the south end of the room, and in the wooden box in which a set of four instruments is displayed as furnished for sea use. In one of the cases which hold the contributions of the Meteorological office, there is a very convenient small pocket thermometer, with boxwood mounting, which is supplied for navy surveying expeditions. The series contained in this department of the collection, and thus specified, very adequately demonstrates the best class of thermometers now used by meteorologists. It will be understood, however, that another large series of thermometers is contained in the gallery above, being there grouped with the instruments classed as measurers of heat, irrespective of their employment for meteorological purposes. Amongst these will be found a set of four, by Dring and Haye (No. 1,023), which conveniently illustrate the different thermometric scales most generally in use, those, namely, of Fahrenheit (already described), of Celsius (also called Centigrade), of Raumur, and of De Lisle. The Celsius scale makes freezing water the zero, and boiling water 100 of the scale, and adopts 100 divisions between the two. In the Raumur scale, which is employed in Sweden, Norway, and Denmark, the zero is fixed at the temperature of ice, and the temperature of boiling water is 80. In De Lisle's scale the zero is boiling water, and freezing water corresponds with 150 degrees. In this part of the collection there are some delicate foreign thermometers worthy of note, which are graduated to tenths of degrees.

MAXIMUM THERMOMETERS.

Thermometers which will register the extreme degrees of heat and cold for a single day and night are indispensable to exact meteorological observation, in all circumstances where very frequent readings of the instruments cannot be made; a pair of such instruments are left duly adjusted for their work, and then in the early morning indications are found on them of the greatest heat of the preceding day, and the greatest cold of the preceding night. The large instrument (No. 2,827*f*), with the white porcelain scale, shows how this matter of registration is managed for the greatest heat, in the form of maximum thermometer, devised by Negretti and Zambra, and which is now in most general use. A short distance above the bulb, but below the horizontal bend, the tube is contracted to a very narrow aperture, by the introduction of a small fragment of enamel, so fashioned as to allow the mercury to pass freely outwards when it is expanded by heat, but which then offers sufficient impediment to prevent the column contained in the horizontal tube from returning to the bulb, until the instrument is raised into a vertical position, and rapped with the fingers, or shaken. When this instrument is looked at in the early morning, the column of mercury shows how far the liquid metal had been pushed out by expansion during the heat of the previous day, and there is a void space between the inner end of this column and the bulb. The instrument is set for the next observation by shaking the mercury back into this space. Pastorelli has two specimens of this form of maximum thermometer, one with a scale of white metal, and one with a black scale and white graduations. Negretti and Zambra's ordinary size of the registering instrument supplied to observatories, with the white porcelain scale, is shown in the observing frame of the Meteorological Society under the first window, and with the contribution from the Meteorological office in the neighboring large case. In Casella's maximum thermometer (No. 2,826*h*), a small bubble of air, introduced into the column of mercury, effects the same object as the scale of enamel; it divides the column when the part lying nearer to the bulb is withdrawn by contraction. The original instrument of this kind, which was first made by Professor Phillips, is shown in front of the end of the case. In Rutherford's maximum, a steel index rests at the end of the mercurial column, and is pressed forward when the mercury expands, but is left in the void space, to indicate the extent to which it had been driven, when it contracts, until the index is very carefully shaken back into contact with the contracted mercury, to prepare it for the next observation.

MINIMUM THERMOMETERS.

The thermometer for the registration of the greatest cold of the night is generally made with spirit of wine in the tube instead of mercury. Spirit of wine has the same advantage with mercury, that it does not freeze at the low temperatures naturally experienced on the earth. Its most common form, the invention of which is also due to Rutherford, is shown by Pastorelli, on his peculiar black vulcanite scale, in No. 2,826*d*. A small glass float, about half an inch long, and with a knob at each end, is introduced into the tube. The knob which is furthest from the bulb of the thermometer is largest and flat. When the spirit expands under heat, it readily flows past this glass float without shifting its place. But when the spirit contracts with cold, its last film, as it retires, seizes upon the float, and draws it back with it by adhesive attraction. When the spirit again expands, it flows, as before, past the float without moving it, and so the float indicates the extreme point to which the spirit had been withdrawn by the cold. The thermometer is again set for the next observation by simply holding it bulb upwards, and shaking it very gently and carefully, until the float falls to the extreme end of the expanded column of spirit. Other good specimens of this very useful and efficient instrument are shown by Negretti and Zambra, with their white porcelain scale, in the end case of the room, and also in the sets of the Meteorological Society and Meteorological office stations. There is also a good instrument on a white metal scale, by Pastorelli, intended for his school and college selection; and one by Hicks, on a white porcelain scale.

Negretti and Zambra have, however, contrived a very excellent recording thermometer for minimum temperatures, in which mercury is successfully employed for the column instead of spirit. This mercurial minimum thermometer is shown in the end case (No. 2,827*b*), and will at once be recognized by having a small supplementary tube, or horn-like projection, curving over the end of the main tube near the bulb. A small plug of platinum is introduced into this short appendage, and the column of mercury in the main tube is, it will be observed, a very fine thread. The plug is so arranged that when the thread is influenced by the contraction of cold, it is withdrawn into the bulb. But when the mercury is afterwards expanded by heat, the liquid metal is pushed under the expansion past the plug into the short horn of the tube, instead of into the long central bore. The thread consequently remains in the position to which it had been withdrawn by the cold, and shows on the morning inspection how far it had been so withdrawn, or, in other words, how great the cold has been. The instrument is set for the next observation by shaking the mercury back out of the short horn-like appendage into the general column of the instrument.

Maximum and minimum thermometers are commonly mounted as pairs in the same case, or upon one common slab. Hicks shows a good pair connected together in this way. There is a very convenient and handsome pair, by Pastorelli, on white metal scales, which are fitted into a small pocket case, lined with purple velvet; and also another pair, by the same maker, which can be attached to a brass frame, screwed into the lid of the mahogany case that contains them when in use. These last have a black vulcanite scale with white graduations. The observing frame of the Meteorological Society, and the college frame of Pastorelli, show how the maximum and the minimum registering thermometers are ordinarily placed in observing stations.

REGISTERING THERMOMETERS.

The registering thermometer known as Sixe's gives both the greatest heat and the greatest cold with only one instrument. The principle employed in the construction of this piece of apparatus is very effectively illustrated in the large specimen (No. 2,826*a*) exhibited by Pastorelli, in which the thermometer is mounted upon a slab of transparent glass, with black figures and graduations. It will be observed that the glass tube of the thermometer bends twice upon itself, and in this way is distributed into three parallel limbs. The central portion of the tube is occupied by mercury; but there is spirit in the tube at each end. In one limb, however (the one towards the left-hand), this spirit presses at the outer end against a closed vacuous part, and in the other limb (the right-hand one) against a reservoir which contains a small portion of air. Immediately above the mercury, and in the spirit at each end, there is a float, or index, composed of a small piece of iron wire capped at each extremity with enamel. There are also fine springs of spreading bristles, attached to each float in such a way that they press with some firmness against the whole surface of the tube. Without these springs the index would always fall by its own weight, until it rested on the top of the mercury. But, having these springs, the index is lifted by the column of mercury when it presses it up, but then remains fast in the tube in the position in which it has been lifted, when the mercury afterwards drops away from it. With increase of temperature the spirit in the closed side of the tube expands, and drives the mercury up at the opposite end, lifting the index before it to register the greatest expansion. The air at the top of the spirit is compressed, to allow this movement of the mercury to occur. With decrease of temperature the spirit in the closed part of the tube contracts, and the mercury is driven back against it by the elasticity of the air at the other end, lifting, however, the index at that end, to indicate how great the contraction has been. The two indices, therefore, act independently, and are left clinging in opposite ends of the tube, one indicating the greatest heat and one the greatest cold. The instrument is prepared for a renewed observation by drawing back the two iron wire indices into contact with the mercury, by passing a magnet along the side of the tube. Pastorelli exhibits also a second instrument of this same construction, just above, in which the scales are of white porcelain, with black figures; and a third form, in which there are only two arms to the tube, instead of three. In this, however, the principle is identically the same; it is merely the proportions of the instrument which are changed, so as to allow the two end columns of spirit to be introduced within the dimensions of the instrument. The closed end of the tube is sometimes conveniently turned round upon itself into the form of a convoluted spire, and the instrument then only has two branches, the additional length required for the spirit at one end being in that way compactly and conveniently provided for. There is a good form of Sixe's thermometer, also exhibited by Dring. The Sixe's thermometer is somewhat of a favorite for ordinary domestic and quasi-scientific use, on account of comprising within itself the registration of extremes of both heat and cold, but it is liable to derangement in unskillful or careless hands; and is, practically, superseded in observatories at the present time by Rutherford's spirit minimum and Negretti's mercurial maximum, which, with Negretti's equally excellent mercurial minimum, may now be said to be the accepted and standard instruments for thermometric registration

RADIATION THERMOMETERS.

Thermometers are especially provided for marking the results of radiation from grass, and for ascertaining the direct heating power of the rays of the sun. The first are termed terrestrial radiation, and the second solar radiation thermometers. The form which is usually given to the terrestrial radiation thermometer is shown in an instrument of Pastorelli's, in the end case, and of Casella's in the Meteorological Society's frame. The instrument is a minimum spirit registering thermometer, with a forked tube taking the place of the bulb. It is graduated on its own tube, and enclosed in an outer glass jacket. When in use, it is supported with one end in a fork, and the bulb is placed resting on the grass. The form of the solar radiation thermometers is exhibited in the end case, in No. 2,827*i*, which is an ordinary registering maximum thermometer, with its bulb blackened to facilitate the absorption of solar heat, and which is also enclosed in a large outer tube, from which all air has been removed. In this specimen, which is one of the best of its class, a small vacuum gauge is placed in the interior of the glass jacket, to indicate the perfection of the vacuum. All air is removed from the interior of this jacket, because if present there it would receive and communicate some heat on its own account, and so vitiate the result furnished by the thermometer. The group of instruments in front of the first window, belonging to the Meteorological Society, shows how this instrument is placed to receive the full influence of sunshine, but it will be observed there are two radiation thermometers here, of which one has a blackened and one a bright bulb, in order that the difference of solar effect in the two circumstances may be compared. In the Meteorological office contribution, contained in the third large case, there is a solar radiation thermometer, in which the perfection of the vacuum is tested in another way. Platinum wires are inserted through the glass jacket at each end, so that a voltaic current may be passed through the vacuous space within. The color of the light when this is done indicates the state of the vacuum.

Amongst the special forms of thermometers there is one in the Meteorological office contribution which is worthy of notice. It is marked the "thermometre fronde," and is a small thermometer attached to a silk cord, so that it may be swung rapidly round in the air. It is found that the thermometer at once takes up the true temperature of the air, when it is swung round in this way, just as it would if the air were blown upon it in a strong steady current. In the first large case there is a French thermometer, which looks precisely like an aneroid barometer, in which the expansion is secured from a metallic bar. There is also a Swiss metallic thermometer, by a maker of Berne, in which a sharp coiled spring, of about six convolutions, presses its point against a pin, and lifts an index on the right hand when it expands, and does the same thing on the left hand when it contracts. The extremities of both indices range along a graduated arc beneath, and retain their position of furthest extent by slight pressure and friction against the arc. The instruments marked as terrestrial thermometers, at the right-hand side of the case, are simply four thermometers, in outer protecting jackets, of identical construction, fixed upon blocks of wood of different lengths, so that they can be sunk in holes in the ground to different depths, for investigating the temperature of the soil.

CLOCK REGISTER THERMOMETER.

It is, of course, a matter of some moment that the meteorologist should have the means of getting the temperature of any given hour of either day or night at will by automatic registration. Negretti and Zambra provide for this need in a very ingenious way, which they term their "patent recording thermometer," No. 2,827*c*. The tube of the thermometer is bent at the middle so as to form two parallel vertical arms, and it is contracted at its union with the bulb, so that when it is turned over and upside down, all the mercury which is in the arm above the contraction runs round into the other branch of the tube, and there measures exactly the same length, and indicates the same number of degrees on the scale that it did in the first branch in the original position. The clock which carries the thermometer is set like an alarum. It turns the thermometer over, and so secures the register of the temperature at the hour at which its mechanism and hands are set.

DEEP-SEA THERMOMETERS.

This very ingenious piece of apparatus has been adapted also as a deep-sea thermometer, to furnish the temperature of the water at any desired depth. The arrangement by which this is accomplished is shown in 2,827 *h*, in the same case. The thermometer is contained in a strong and heavy brass frame, finished at the bottom by a propeller-like spiral fan. When this heavy frame is dropped into the deep regions of the sea, the fan revolves as it passes through the water, and if at any depth the descent is suddenly stopped, and the frame drawn upwards for a brief space, the revolution of the fan is necessarily reversed. The mechanism, however, is so arranged that when the revolution is reversed the thermometer is turned over and the temperature registered. The reversal of the fan thus takes the place of the clock movement in the other instrument. With these deep-sea thermometers it has been found necessary to protect the instrument from the pressure to which it was exposed at great depths. The pressure acts even through the glass, and drives the mercury up from the bulb, so as to cause it to indicate a temperature higher than the one to which it has been exposed. A pressure of 21 tons upon the square inch, which is reached at a depth of a few hundred feet, causes an error in this way of nine-tenths of a degree. The deep-sea thermometers on this account are now enclosed in a very thick and strong outer jacket of glass, which shields them effectually from this source of derangement. A thermometer upon the shelf, just above the apparatus, has one half of this outer thick shield removed, to illustrate the contrivance by which Messrs. Negretti and Zambra have conquered this difficulty. Other forms of deep-sea thermometers, some of which have been in use, are also shown. One, constructed also by Negretti and Zambra (3,019), is simply a Sixe's registering thermometer with an outer protection for the tube. A similar instrument, by Casella, No. 3,021, is also shown, which was found to give erroneous results at great ocean depths. Both these instruments were used in the early deep sounding in the North Atlantic. A third Sixe's thermometer, by Casella (No. 3,021), of later construction, has an outer protection, and has been tested up to two tons to the square inch. This is the form of deep-sea thermometer which has been in use in the soundings of the Challenger, and which has been found to give readings correct within a very little more than a degree at depths of three thousand fathoms. Two of these protected thermometers were, however, broken by the pressure at a depth of 3,875 fathoms. An old unprotected instrument, by Pastorelli, is shown, in which the error amounted to more than nine degrees with a pressure of two tons on the square inch.

SELF-MOVING AND REGISTERING THERMOMETER.

There is a very notable instrument in this department of the collection (No. 2,826*m*), called a "Continuous Self-registering Thermometer," which is exhibited by Mr. W. Harrison Cripps, and which deserves something more than a passing glance on account of the great ingenuity and originality of its design. It consists essentially of a long tube of glass coiled into a flat whorle of six spires, constituting a kind of wheel about five inches in diameter. This is delicately hung upon a transverse axis passing through its centre, which allows it to revolve to and fro. The five inner coils of the tube are filled with spirit of wine, and one-half of the large outer coil contains mercury. The consequence of this arrangement is that, as the spirit in the inner coils expands and contracts under varying influences of heat, the mercury is impelled by it in one or the other direction. But as mercury is a heavy material it acts as a weight, and always keeps itself in the lowest part of the spiral tube; in other words, as it moves to and fro, it revolves the wheel forwards and backwards. But the wheel carries a grooved circular plate, of about two inches diameter, upon its axis, and from the circumference of this plate a silk cord passes down to a pencil that slides upon a vertical rod. The point of this pencil rests upon the surface of a vertical drum, which is carried round by clock-work once every seven days. A trace is in this way inscribed upon the papered surface of the drum, which very accurately marks the oscillations of the temperature for the period of a week. This "continuous self-recording thermometer" stands upon a pedestal of its own, very nearly opposite to the bust of Galileo.—*Journal of the Society of Arts.*

FRENCH ACADEMY OF SCIENCES.

DECEMBER.

On the Correction of Variations in the Motion of Pendulums of Astronomical Clocks, due to Barometric Pressure. By M. REDIER. Careful experiments made at Brussels, Berlin and London, have proved that a second's pendulum varies $\frac{1}{10}$ of a second per day, between two extreme barometric pressures. If regulated at a pressure of 28.47 inches, at 30.81 inches it becomes retarded to the above amount. To compensate for this error, M. Redier places an aneroid barometer above the bob, and arranges a weight, which, when the atmosphere pressure augments, is lifted toward the point of suspension of the pendulum, so that the latter consequently travels correspondingly faster. A diminution in pressure produces an inverse result.

On the Disengagement of Ammonia due to the Rupture of Certain Bars of Steel. By M. BARRE. On breaking under the hammer two steel rails of different degrees of hardness, the harder steel disengaged a quantity of ammonia, sufficiently strong to be smelled at some distance away. Red litmus paper and yellow curcuma paper when applied to the moistened fracture immediately changed color, the first becoming blue, the second brown. Bubbles of gas appeared on the wet surface during fifteen minutes. With the softer steel, the disengagement of ammonia was less noticeable; but the action upon the test papers was quite marked. These results have been observed with Bessemer and Siemens' steels.

On Urea in the Blood. By M. PICARD. This author finds in arterial blood two different substances, both decomposable by Milon's reagent. One, highly destructible, disappears almost completely in the capillaries; the other is fixed, resistant, and exists in the veinous blood in the same quantities as in arterial blood. As to the nature of the first substance, M. Picard is able to draw no conclusion; the second, he believes to be urea of the blood.

On the Fabrication of Sugar. According to Mr. Hermann and Bernard, magnesia may be advantageously substituted for lime in the defecation of the juice of the sugar beet. The liquor is thus not rendered alkaline, and the use of acid to neutralize it is not required, while the magnesia does not (as does lime) develop a sucrate, so that a gain of 5 or 6 per cent. in manufactured product is accomplished.

THE CHEMISTRY OF COAL.

From a recent lecture by DR. FRANKLAND, F.R.S.

CARBON and hydrogen form the most important constituents of coal, and it is from these two constituents alone that we derive all the mechanical force when we burn coal. We have now to consider how coal is put together by Nature, and how the powerless materials, carbonic acid and water, became invested with force, and converted into powerful matter. The transformation is effected through the agency of plants, and the power with which they become invested is derived from the sun. Light and warmth are necessary to vegetation, and although a minute fraction of light is derived from the stars, and of warmth from the central heat of the earth, yet these are so minute as to be insignificant compared with the light and warmth afforded by the sun; and, therefore, we may affirm that the light and warmth by means of which plants are able to convert these powerless into powerful materials is derived exclusively from the sun.

We have experimented with carbonic acid water, and with the elements carbon, oxygen, and hydrogen composing these bodies, and found that the elements when separate constitute powerful, and when combined powerless, matter; the separate elements are invested with force, the combined elements are not invested with force. It will be desirable to approach gradually to the consideration of what constitutes the difference between powerful and powerless matter. Here is an iron ball suspended by a string, and hanging freely; if it be drawn on one side it differs from the ball at rest, inasmuch as it is invested with force, it is powerful, and when let go swings back beyond its former position of rest. The difference between the two positions of the ball illustrates the difference between the carbonic acid and water on the one hand, and the powerful materials into which they can be decomposed on the other. Here, again, are two suspended magnets; at present they are held fast together by their mutual attraction, if separated to a small distance (by the expenditure of a certain amount of mechanical force) they again rush together, and in so doing are capable of exerting a certain amount of mechanical force. The combined magnets are powerless, the separated magnets powerful bodies; and in this case again we have an illustration of the difference between the combined carbon, hydrogen, and oxygen on one hand, and the separated elements on the other. When the ball or the magnets pass from a state of motion to a state of rest they each lose something—motion, and that motion can never be annihilated, but is converted into heat. That heat is thus produced on the stoppage of a moving body, the lecturer proved by allowing a moving ball to strike against a substance which readily took fire with a slight increase of temperature. Just as matter becomes invested with power when set in motion, so do the elements which compose carbonic acid and water become invested with power when they are separated; the force necessary to separate them invests them with a large amount of power. You must picture to yourselves chemically powerful matter as particles of matters which have been pulled asunder, and are capable of rushing together again when brought into proper conditions. Starting from the conception of mechanical power, you will not find much difficulty in comprehending somewhat of the nature of chemical combination, and in perceiving the source of the heat and light in the destruction of the motion of the elements which rush together when they enter into chemical combination. In the process of forming coal the solar rays pulled asunder these elements; they transformed the carbonic acid and water first into wood fibre through the apparatus of the plant, and in this way the carbon, oxygen, and hydrogen are invested with an enormous amount of force, equal to that which they afterwards give out when they combine. It is correct to say that the heat and light which we now obtain from coal is a portion of the sunshine of past ages. In this flask there are 139 grains of oxygen, which is just a sufficient amount to combine with the 52 grains of charcoal or carbon put into it. The combination is attended with the evolution of great light and heat, and, in fact, the force of combination is equal to that which would raise 1 ton weight from the floor of this theatre to the ceiling, or which would be generated in the fall of 1 ton weight from that height. Such are the tremendous forces in action around us; the trees of the forest drink in the sun's rays, and in their action on the carbonic acid and water which are present in the air around them, and in the juices of the plant, they perform the first stage in the manufacture of coal. The sun's light and heat are engaged in the green leaves of the trees in pulling asunder the elements of the carbonic acid and water, and the amount of force thus stored up in one day in a forest of trees is enormous. A moderate sized geranium may be proved by actual experiment to become invested in one long bright summer day with an amount of force equal to lifting 1 ton weight to the height of 2 feet. The material furnished by the plant is wood, and in this wood is stored up all the force necessary to transform it into coal; it may now be buried and hid from the sun's light and heat, and requires no more work to be done on it; all the actual work is done when the carbon, oxygen, and hydrogen are pulled apart on the green leaves of the plant. In the condition of wood, however, it contains a considerable quantity of powerless matter—carbonic acid and water—the powerful constituents are loaded, so to speak, with a great weight of powerless matter, and it is the removal of the greater part of this load which converts the wood into coal and renders the latter material so much more valuable. Dry wood contains 40 parts of powerful and 60 of powerless matter in 100. In the presence of moisture wood is subject to decay; it gradually moulders away, but when the air is excluded it gives a material which we know as peat, and which is the next step towards coal. In peat a small quantity of the powerless matter has been got rid of, for it contains 47 parts powerful to 53 parts powerless matter. This chemical process of change—the getting rid of the powerless carbonic acid and water—goes on, and, as may be seen in the lower part of old peat bog, the material begins to solidify, and this brings us to the next step, which is lignite or wood coal. This lignite is much used in some parts of Europe as fuel; it contains just as much powerful matter as the wood from which it originally started, and more than the coal which will be derived from it—in 100 lbs. there are 58 lbs. powerful and 42 lbs. powerless matter. Up to this stage no powerful matter has been lost, but in taking the next step, which brings us to coal, a portion of the powerful matter is lost in getting rid of a further quantity of powerless matter. This may be readily seen by the fact that fire damp, which occurs in coal mines, never occurs in lignite mines, and fire damp is the form in which the powerful matter is lost in the conversion of lignite into coal. In fact, lignite loses fire damp, carbonic acid, and water, and yields coal, which has 85 parts powerful to 15 parts powerless matter.

We have in coal a concentrated fuel, which in a small space will give out a considerable amount of heat, and heat of considerable intensity; it would not be possible to get from such a fuel as wood the same results we get out of coal. Among coals there are several varieties; there is, for example, the Newcastle coal, which we mostly burn in London; there is Welsh anthracite, which contains more carbon and less hydrogen than Newcastle coal; and there is cannel coal, which contains still more hydrogen than Newcastle coal, and is much used for making gas.

If we examine this marsh gas in the way we examined carbonic acid and water, we find it to be a transparent colorless gas, lighter than either of the two mentioned gases. It burns with a flame emitting little light but much heat, and in burning it becomes transformed into powerless matter—carbonic acid and water, from which at first it was formed. The flame of fire damp will not pass through a piece of wire gauze, which a flame of hydrogen soon makes red hot, and penetrates; hence the possibility of a safety lamp. The safety lamp, however, is not safe under some circumstances, as, for instance, when the gauze has become red hot it is very dangerous, as also when placed in a current, or in the path of the wave of air caused by an explosion. This latter cause has lately been proved to have been one of the most fruitful sources of explosions. Before the invention of the safety lamp the miner had to content himself in dangerous places with the light of the sparks struck from a piece of flint held against a rapidly revolving steel wheel, and the lecturer showed that these sparks failed to ignite fire damp, nor had he ever been able to ignite it in that manner, yet those sparks ignite hydrogen very readily.

Thus we have followed Nature step by step in the process of putting coal together, and see what a wonderful substance we have got. Here is a small mass of coal weighing 2 lbs., yet this is invested with such an amount of force that when burnt beneath the boiler of a steam engine it would furnish for an entire hour the force of a strong horse. A steam engine is an imperfect and clumsy machine, in so far as it utilizes but a small part of the total force of the fuel, for the total force in the 2 lbs. of coal would furnish the force of ten horses for an hour. In order to produce the same amount of force we should have to burn 4 lbs. of wood.

NEW PROCESS FOR TITRATING ASTRINGENT SUBSTANCES.

By M. FERDINAND JEAN.

WHEN we pour drop by drop a solution of iodine into any decoction of an astringent matter, previously mixed with an alkaline carbonate, we remark that this solution is absorbed with a great energy. I have observed that the absorption of the iodine takes place, in these conditions, in the direct ratio of the quantity of astringent matter taken, and that 1 part by weight of tannic acid absorbs 4 parts of iodine before we can observe the presence of free iodine in the liquid. It is on this action of iodine on astringent matters that the process of titration is based which forms the subject of this note. The solution of iodine necessary for titrating tannin is obtained by dissolving in iodide of potassium 4 grms. of iodine, and adding to the solution distilled water in quantity sufficient to make a volume of 1000 c.c. To ascertain the value of the solution of iodine, we introduce into a beaker 10 c.c. of a solution of tannin at 0·1 grm. per cent.; we mix it with 2 c.c. of an alkaline lye containing 25 per cent. of crystallized carbonate of soda; then, by the aid of a graduated burette, we cause to fall into the alkaline liquid the solution of iodine until a drop of the mixture, taken with the glass stirrer and put on a leaf of starched paper, produces a light violet spot, which indicates the presence of free iodine and the end of the operation. The value thus obtained must be corrected, that is to say, we must deduct from the number of cubic centimetres of the solution of iodine corresponding to 0·01 grm. of tannin, the volume of this solution, which it is necessary to employ as pure loss before obtaining a colored reaction on starched paper. For this purpose we measure 10 c.c. of distilled water, which is mixed with 2 c.c. of the alkaline solution; then we pour, drop by drop, the solution of iodine until we obtain a spot on the starched paper. With a solution of iodine, containing 4 grms. iodine per litre, the correction is commonly from 0.1 c.c., but the greater or less purity of the carbonate of soda may perhaps affect this correction very slightly. For 0·01 grm. of tannic acid dissolved in 10 c.c. of water we must generally use 10·5 c.c. of the solution of iodine at 4 per thousand. Under the influence of iodine the alkaline solutions of tannin, even diluted, take a coloration so intense that it would not be possible to seize distinctly the coloration of iodide of starch if we added starch paste to the tanniferous liquid. This is why I have recourse to a leaf of white filter paper, which I cover by friction with a slight layer of powdered starch. The spots made on this paper with half a drop of liquor containing traces of free iodine are immediately absorbed and show the characteristic violet coloration, even when the liquid is deeply colored. When the value of the solution of iodine is established with respect to a known weight of pure tannic acid, this test liquor may be employed to titrate the various astringent matters, if we adopt, as the authors of the processes for the determination of tannin hitherto published have done, tannic acid as the type of the active principle of astringent matters. But, if we wish to make very exact researches, it is necessary for each variety of astringent matter to be studied to ascertain the value of the solution of iodine by means of the pure astringent principle; for example, catechuic acid for catechu-moritannic acid for fustic; for the solution of iodine acts, without doubt, like other re-agents in different proportion upon divers tannic acids. The tannic acid which I employ to establish the value of the solution of iodine is obtained by keeping the tannin of Pelouze at 80° in the water-bath. At this temperature a portion of tannin, about 42 per cent., melts, agglomerates into a greyish spongy mass, which contains the impurities of the tannin with the resins; the pulverulent part constitutes pure tannin and 10·5 c.c. of the solution of iodine at 4 per thousand correspond to 0·01 grm. of this tannin, whilst only 9·3 of the solution of iodine are required to saturate 0·01 grm. of the gummy matter. The titration of tannin by means of the solution of iodine being very rapid and very exact, I determined to apply it to the assay of natural astringent matters. For this purpose I had to ascertain whether the matters which accompany the tannin in vegetable extracts are without action on the solution of iodine. For this purpose I exhausted with 100 c.c. of distilled water 1·515 grms. of oak bark, which, assayed according to Hœner's process, contained 6·5 per cent. of matter fixable by hide, and I performed in 10 c.c. of this decoction, containing consequently 0·01 grm. of tannin matters, the titration with a solution of iodine of which 10·5 c.c. corresponded to 0·01 grm. of pure tannic acid. If the extractive matters which accompany the tannin had acted on the solution of iodine, I should have had to employ more than 10·5 c.c. of this solution; but in three assays I obtained the colored reaction on starched paper. After having poured 9·8 c.c. of the solution of iodine, I found then 5·92 c.c. per cent. of tannin instead of 6·5 c.c., the value found in using Hammer's process. The discrepancy of 0·58, which the two processes give, must be attributed to the coloring matters which have been fixed by the hide along with the tannin in the assay by Hammer's process. In a second experiment I treated the same decoction of oak bark with an excess of powdered hide, and having separated by filtration the hide charged with tannin, I obtained, with 10 c.c. of the filtered decoctions, the re-action upon the starched paper, after having employed 1·7 c.c. of the solution of iodine; whilst before the action of the hide it would be necessary to employ 9·8 c.c. But these 1·7 c.c. of solution of iodine corresponded to 1·02 per cent. of gallic acid, the average quantity of this acid which has been remarked in French barks. Finally, a decoction of oak bark was precipitated by acetate of copper. The tannates and the gallate of copper were separated by filtration, the filtered liquid was neutralized by carbonate of soda, then filtered anew to separate carbonate of copper. 10 c.c. of the clear solution, after an addition of 2 c.c. of a lye of carbonate of soda, only required 0·1 c.c of the solution of iodine to produce a colored re-action upon starch. This result shows very clearly that the extractive matters do not act on the solution of iodine, since we have only employed of this solution the volume which would have been necessary if we had operated upon distilled water, and, nevertheless, the liquor separated from the gallate and the tannate of copper contained all the extractive matters, save a small quantity of brown acids which the acetate of copper had precipitated. Having shown that in the decoction of oak bark it is only tannic and gallic acids that absorb the solution of iodine, the process of titration that I propose may be employed with all safety for the assay of tanniferous matters. I have found that crystallized gallic acid decomposes the solution of iodine exactly in the same ratio as tannic acid. If, then, we wish to determine separately the gallic and tannic acid, we must determine at first the volume of the solution of iodine corresponding to the two acids jointly; then, after having separated the tannic acid by powdered hide, titrate the gallic acid remaining in solution. On deducting from the volume of the solution of iodine corresponding to the two acids that which belongs to gallic acid alone, we obtain the quantity of tannic acid.—*Bulletin de la Société Chimique de Paris.*

APPLICATIONS OF EOSINE.

THE best method of dyeing *wool* consists in the use of alum (not sulphate of alumina), ¾ oz. of alum being sufficient for 2 lbs. 3 ozs. of wool.

We begin with entering the wetted wool into the cold alum beck; then the solution of eosine is added, working the goods and gradually raising the temperature to a boil, finally rinse. With about 1½ oz. of color to 2 lbs. 3 ozs. of wool, a very rich and full shade is obtained, far surpassing the cochineal reds in brightness and intensity.

For *silks* we employ soap becks and acetic acid.

The soap beck contains the solution of the color, to which acetic acid is gradually added, turning the silks and raising the heat to 104° F. and 120° F., and brightening finally with a very weak solution of acetic acid.

Cottons are mordanted with stearate of lead, produced as follows: The goods are worked in a soap beck dried and then transferred to a beck of sugar of lead, where the fibres become coated with stearate of lead, otherwise known as lead soap. The cottons are then rinsed and dyed in an eosine beck at a hand heat. By adding acetic acid to this beck a yellower tone is obtained.

Mixed Goods.—If cotton tissues are padded in a solution of eosine, thickened with gum, and then, after dyeing, steeped in a solution of acetate of lead, they become coated with a very brilliant coating of a red lake, very suitable for artificial flowers and other fancy uses.

In case of mixed goods with a cotton warp the wool or waste is first prepared in a hot alum beck, and the cotton is then mordanted as above directed. The goods are then dyed at a hand heat. At a boil the color is thrown chiefly upon the wool, and the heat employed is therefore a means for causing the color to take evenly upon the two fibres.

Printing upon Silk and Wool.—Eosine is very easily printed upon animal fibres without the intervention of any fixing agent.

It is sufficient to dissolve the color in water, to thicken with gum, and to fasten by a slight steaming. The use of albumen does not appear to be satisfactory as a thickener.

Printing on Cotton.—The ordinary methods for fixing aniline colors upon cotton do not succeed with eosine, as it does not combine with tannin, alumina, and the other common mordants, and does not give bright shades with albumen and caseine (lactarine).

The following methods are employed: The goods are prepared with tin—either tin crystals or stannate of soda—and a solution of eosine thickened with gum, and mixed with arsenite of alumina, is printed on. The pieces are then steamed and washed. Or the goods are prepared with oxide of lead, and a solution of eosine and soap, thickened with gum, and then printed on.

The following method may also be taken:

The pieces are padded in gelatine, and the thickened solution of eosine above mentioned is printed on, tannin having been added in the proportion of three parts to one of eosine.

This last method gives the best results, but in all cases pieces printed with eosine must not be soaped, and they stand light worse than goods dyed with the same color.

Alcoholic Eosine.—Latterly the manufacturers of aniline colors have begun to offer a new quality of eosine distinguished by its more blue tone, its different solubility, and its reputed superior fastness.

Whilst ordinary eosine is perfectly soluble in water, this kind dissolves only in a mixture of alcohol and water, rendered slightly alkaline by the addition of a little carbonate of soda. It is known in commerce as "alcoholic eosine," or as "primrose" (a very unsuitable name for a color more blue than true eosine. The name "primula," moreover, has been already applied to certain aniline violets).

The color is dissolved in the following proportions:

Eosine	10 parts.
Water	100 "
Alcohol at 36°	100 "
Soda crystals	1 "

The solution is made in the water-bath, and must be employed hot, as the coloring matter is deposited on cooling.

Alcoholic eosine dyes wool in the same manner as the ordinary kind, but for light shades the alum is omitted.

For dyeing cotton, the latter is mordanted with oxide of lead by the usual methods. It may be steeped in a strong solution of sugar of lead, dried, and then taken through a clear lime water to precipitate the oxide of lead upon the fibre.

When thus leaded the cotton is dyed in the eosine beck, and takes at once a very beautiful shade, much superior to that produced with saffranine (extract of safflower).

If there is any reason for not employing lead the cotton is saturated with a glutinous mordant, prepared by stirring up wheat flour in water till a fluid paste is formed, which is allowed to settle, and the clear liquid is then used as a mordant.

Cottons may also be worked in a solution of egg-albumen, and dried at a temperature of at least 140° F., when they are fit for dyeing in the alcoholic eosine beck.

Mixed cotton and woollen goods are dyed in the same manner as with common eosine.—*Le Teinturier Pratique.*

ROSOLIC ACID.

By C. LIEBERMANN and F. SCHWARZER.

THE coloring matter formed by the action of concentrated sulphuric acid upon salicylic aldehyde is very readily formed. The mixture needs only to be heated for an instant at a steam heat, when it is transformed into a solid red mass. This product dissolves in alkalies with a violent red shade. Acids precipitate it in red flakes. It presents a great analogy with rosolic acid, but it is distinguished by the slighter solubility of its magnesia salt, by the red color of its salts, and of the precipitate given with acids.

The formation of rosolic acid from salicylic aldehyde is explained by the previous production of phenol. This has led the authors to study the influence of phenol upon this reaction, and to see if true rosolic acid could thus be formed. Experiment has confirmed this idea.

A mixture was made of one part of phenol, two and a half parts salicylic aldehyde, and one part of sulphuric acid diluted with one third its weight of glacial acetic acid. Heat is disengaged to such an extent that cooling is necessary. To complete the reaction it is boiled in the water bath, and the resinous product is purified in the ordinary manner. The rosolic acid thus obtained is identical with that of Kolbe and Schmitt.—*Ber. Berlin Chem. Gesell.*

ON ANILINE BLACK.

By M. R. NIETZKY.

IN a preceding notice the author mentioned a new blue coloring matter, obtained by the action of aniline on aniline black at an elevated temperature. To prepare it, we exhaust crude aniline black several times in alcohol; we transform it into a free base by diluted soda, then into acetate by moistening it with acetic acid. We dry this, and heat it in a retort, with eight or ten times its weight of aniline, at 150° to 160°. The action was very slow; to come to a complete transformation, it is necessary, according to the quantities employed, to heat from six to eight days.

By raising the temperature we accelerate the reaction, but we then obtain secondary products, which render the purification of the coloring matter difficult. We interrupt the operation when a sample dissolves almost completely in alcohol. We then pour the mass into a large quantity of diluted muriatic acid, which dissolves the aniline, along with a large quantity of impurities, whilst the coloring matter is precipitated as a muriate. This salt was dissolved in alcohol, the alcohol partially distilled, the base precipitated by water and diluted soda, and purified by repeated solutions in ether, and precipitation from this solution by muriatic acid. The ethereal solution of the pure base was of a beautiful red color, resembling magenta. On adding an acid, the corresponding salt was entirely precipitated. The muriate purified in this manner crystallizes on cooling its alcoholic solution in small needles of a coppery lustre. It was crystallized several times in diluted alcohol, to which we took care to add each time a little muriatic acid to prevent a loss of the acid of the salt. A violet-reddish matter remained in the mother liquors, whilst the salt itself took a blue coloration more and more pure It is easily dissolved in alcohol, not in ether and water. The blue color of the alcoholic solutions is turned to crimson by the fixed alkalies and by ammonia. The alkaline solution of the base, like that of the neutral solution of the salts, is decolorized by boiling with zinc powder, but the color returns immediately in the air. The acid solutions are equally decolorized by zinc.

Concentrated sulphuric acid dissolves this body with a blue coloration; on heating, there is formed a sulpho-conjugated acid. Concentrated nitric acid, ever fuming, dissolves it apparently without alteration, and with a blue color, but on heating it is decomposed.—*Bericht Berlin Chem. Gesell.*

VANADIUM ANILINE BLACK.

FOR dyeing aniline black, Guyard recommends the following process, premising that for cotton the quantity of the salt of aniline may be diminished, and for wool may even be doubled. The standard dyebeck will consist of—

Water	35 fluid ozs.
Muriate of aniline	2¾ ozs.
Chlorate of potash	1½ to 1⅝ oz.
Chloride of vanadium	1½ grain.

In this we steep the yarns or cloth, well prepared, which merely signifies perfectly freed from fatty matter. They are completely and uniformly saturated with the mixture, and are then hung out in well-aired oxidizing chambers, kept at a temperature of 59° to 68° F. The heat is then raised to 95° to 104° F., and is kept up till the goods are perfectly dry. If the black has acquired the desired tone and intensity, they are taken through a beck of bichromate of potash, 150 grains per 35 fluid ozs. of water, dried again, and washed with soap and water. If the black is not intense enough, the goods, after drying and washing, but before chroming, may be steeped once or twice more in the beck above mentioned, ageing after each immersion. The chrome counteracts the slightly greenish tint of the aniline black.

POISONOUS WELLS.

IN Dr. Frankland's elaborate paper on the examination of potable waters, there are one or two points which are of sufficient interest to be worth remarking on. Probably many of you have read all that is there said of the case reported from Switzerland, of the conveyance of typhoid fever for very nearly a mile in distance through a water supply. The two experiments cited are so interesting and so ingenious, and lead to such exceedingly important practical results, that I may go into them a little in detail. In the first instance, to establish the fact that the source of the water supply from which the contagion was supposed to have been derived in the first instance was really in connection with the public wells, which were supposed to have conveyed the disease, the following experiment was made: Some hundred-weights of common salt were put into the suspected water supply, and in the course of a comparatively short time the quantity rose in the *well water* to sixteen or eighteen times the normal amount.

PROFFESSOR TYNDALL'S MOTES.

I NEED not remind you of the "motes in the sunbeam," which Prof. Tyndall has happily adopted as the term to designate the somewhat indefinite suspended matter of the atmosphere, but I may just illustrate by experiment his beautiful demonstration of the probability of the organic character of—at any rate by far the larger portion of—that suspended matter. If we turn on this lime light, and bring below its track, marked out in the air of the darkened room, a Bunsen burner, you see the appearance of smoke produced by the heated air traversing the light track, and destroying the suspended matter. Now, extending the application of this process, Prof. Tyndall has constructed an apparatus, of which we have a rough working model before us on the table. We have here a box which can be closed practically dust-tight. We have the means of transmitting a powerful beam, such as we have just been using, from side to side of the box, and so observing whether there is any difference in optical deportment of the air inside the box and the air outside it. We have, of course, in front the means of observing this; and we have a small door fastened dust-tight, by which we can keep the box in communication with the external atmosphere, or not, at will. Lastly, we have an aperture above, through which we can pass the point of a pipette. We varnish the sides, top, and bottom of the box with a mixture of glycerin and water, to act as a mote trap and detain the suspended matter which settles upon it. Then, closing the different apertures of the box, we leave it to itself for a few days, and from time to time examine it with the help of such a beam (or a stronger one), as you have just seen. After a time the whole of the motes in the little portion of included air have settled on the sides and bottom of the box. The track of the beam of light can no longer be distinguished inside the box, although we can see it easily before it enters and after it emerges; and now our air is optically pure, and in a condition to commence experimenting with. Then, passing through the pin hole the pipette, we fill by its means the test tubes which you see are cemented into the bottom of the box with an infusion of any animal or vegetable matter you choose. We abandon these, after heating them to rather above boiling point by a salt bath below, to their own devices. Now, Dr. Tyndall has repeated this experiment with some 600 different test tubes containing every variety of infusion, and he has found that when the tubes have been heated to boiling in contact with the mote-free air, and then abandoned to themselves, they have never in any one case undergone the action which we style putrefaction, and after they have remained for some time unputrefied the mere opening of the box is sufficient in two or three days, by the action of the motes in the air from outside, to initiate with unerring certainty the phenomenon of putrefaction. I cannot see how we can logically come to any other conclusion than that this phenomenon, and, probably, its close ally fermentation, depend upon the action of what Prof. Tyndall calls motes. Others perhaps would give to them the name of germs, but if we call them motes we commit ourselves to nothing except that the suspended matter of the atmosphere is closely connected with these phenomena. I should weary you if I were to go into detail on the different forms in which this experiment has been repeated. You will find them described at length in the original paper, and the more you read the more I think you will be possessed with a sense of their beauty. But there is one part of the experiments which is so exceedingly interesting, both theoretically and practically, that I must attempt its description. Let another set of tubes be connected with the sides of this box; let them be filled with a putrescible fluid; let that undergo the action of putrefaction; and when that action is at its highest, and when the gases evolved during it have completely filled the box, let the lower tubes be also filled with a putrescible fluid, by means of the pipette. Let that be boiled and abandoned to the action of the gases evolved during putrefaction, and in no case will it undergo putrefaction. It may be in the fullest contact with the most nauseous gases from putrefaction, but as long as only gases are brought into contact with it, it will not putrefy; but let the smallest fraction of matter already putrefying be introduced into the "protected" fluid, as we may term it, and putrefaction is absolutely certain. I should probably spend too much time if I were to go into details as to the practical bearings of this experiment, but I think you will see the analogy which Prof. Tyndall points out between this and the not unfrequent case of sewer gas causing zymotic disease is not a far-strained analogy after all. When we endeavor to trace a connection between sewer gas and zymotic disease we are constantly met with this objection: "If it is really the dreadful thing it is said to be, why is there not disease in every house in which it may be smelt?" Not to dwell on the probable necessity for a favorable *nidus* as well as for the germ, in order to initiate that class of disease, I may point out that here the sewer gas, instead of being actually the cause of disease, simply tells us, by its unmistakable smell, that communication is established between the drain and the house—it may be to bring in only comparatively innoxious gas, but it may be to bring in a current of gas laden with zymotic poison, which we may liken to the motes in this box. And the more you consider this case the more you will see the close bearing this experiment of Prof. Tyndall's has upon a matter which concerns our public health in the closest degree.—*Newcastle Chemical Society—President's Address.*

INFLUENCE OF DIFFERENT COLORS UPON VEGETATION.

By M PAUL BERT.

THE author has undertaken some new experiments upon the influence of different colors upon vegetation. These experiments performed chiefly upon the sensitive plant, lead to the following results: Green light kills plants; plants submitted to the influence of the green ray die in a short time. Under the influence of the red rays the sprays become elongated; the leaflets are raised so as to form a smaller angle with the branch than in the normal state, the plant appears to become etiolated and yet it remains alive. Under the influence of the blue rays the process is reversed, the leaflets become perpendicular to the branch, whilst in white light an intermediate position is maintained (*i. e*, the leaflets form with the branch an angle of 45° on one side and of 75° on the other). M. Bert explains these facts as follows: At the level of the point of attachment of the leaflet there is a motor enlargement, which increases or lessens in force according to the different kinds of rays. Under the influence of the red rays there is formed in these enlargements a particular substance, osmotic, and capable of attracting water. This substance generally disappears under the influence of the blue rays. If we place it under a glass shade, red on one side, and green on the other, the plant turns its leaflets towards the green, that is to say, towards the color which kills it, and in fact it dies.

USEFUL RECEIPTS.

Aniline Lakes.—Dissolve in 17½ ozs. of alcohol, at 95 per cent., 150 grains copal and 15 grains magenta. Filter, and add dry white starch to form a uniform mass. Dry and powder. Other colors may replace the magenta, giving different shades,

Liquid Tartar.—Grey tartar on white argol, 10 lbs.; sulphate of soda crystals, 10 lbs.; dilute sulphuric acid, at 90° F., 6 quarts. Set it at 17° F.

Best Size.—Horn sloughs, 4 cwt.; boil for ten hours; strain and add alum and sulphate of zinc, in powder, 3 lbs. Stir it in well, and receive in shallow vessels, and cool.

Bleaching Soap.—Take a common soda soap, dissolve in little water, and salt it out. Add to it ¼ of its weight sulphite of soda, previously made into a paste with a little water, and dry the whole together. For use dissolve it in its own weight of cold water, and for every 2 lbs. of soap add ¼ oz. liquid ammonia. When it has become a soft jelly dissolve in eight times its own weight of water.

To Hinder Tannic Acid Solution from passing into Gallic Acid.—Add a little carbolic or cresylic acid.

Fustic Carmine.—Powder morintannic acid finely, and rub with strong sulphuric acid. From the brownish-yellow solution a brick-red mass separates, which gives, with a little ammonia or soda, a splendid carmine solution. It yields a red lake with alum and a little soda, red lakes, differing in shade with chloride of tin and chloride of barium, and a cheery red lake with nitrate of lead.

Green Varnish.—Boil 15 parts powdered resin in 18 parts of water in an iron pot. Add slowly two parts of soda crystals dissolved in 5 parts of water and boil again; add as much more soda in solution, and boil till all the resin has disappeared. Cool, and let it stand till quite clear. Mix the clear liquid with sulphate of copper in solution as long as a precipitate is formed, filter off, and dry. It dissolves in oil of turpentine, forming a fine green varnish.

Vegetable Bronzes.—1. Extract 10 lbs. Brazil wood in soft water, let it stand for eight days in an open vessel, when pour off the clear liquid into a clean vessel. Heat part of it and dissolve 5 lbs. alum therein whilst hot, and mix with the remainder. Let it stand for eight days, strain off the sediment, and preserve it as a paste. 2. Boil 10 lbs. logwood twice in water, and mix the solutions and evaporate down to one-half. Add 10 ozs. chloride of tin and strain through a cloth. 3. Prepare the logwood decoction as above; dissolve in it 10 ozs. powdered alum, and add about 1 oz. bichromate of potash.

Gold Varnish (proof against air and light).—Digest 2 ozs. best garancine in 6 ozs. methylated spirit, of specific gravity 0·823, in a covered glass vessel, for twelve hours; press and filter. Make a solution of orange-colored shellac in similar alcohol filter, evaporate it to a clear syrup, and color with the garancine as deep as may be desired.

Red Extract of Indigo.—Stir up extract of indigo, as free from acid as possible, in water so as to produce a dark-blue liquid, and add caustic soda lye at 31° Baume. There is formed a dark precipitate and a clear yellow liquid. Let stand for about 48 hours, and then add an excess of oil of vitriol at full strength. A deep red liquid is formed. No heat must be applied. If the alkaline liquor is only allowed to stand for 24 hours it dyes wool a violet.—*Chemical Review.*

DANGEROUS CANDY.

By H. G. DEBRUNNER.

ON a recent trip to Massillon, O., I happened to pass the show windows of a fine confectionery store, where a beautiful display of candies wrapped in brilliantly colored paper of all shades could be seen. My attention was especially directed to some "kisses" enclosed in green paper. Suspecting that the pigment might be Paris green, I purchased a small quantity of the suspected candy, and subjected the paper in which it was wrapped to a careful chemical analysis, with the following alarming results:

Size of one piece of paper	3x2¼ in.;
Average weight of one piece of paper	0·302 grm. (5 grs.);
Quantity of pigment in one paper	0·062 grm. (1 gr.);
Quantity of arsenic, As_2O_3, in one paper	0·032 grm. (½ gr.);
Quantity of cupric oxide, CuO, in one paper	0·022 grm. (⅓ gr.);
Corresponding quantity of met. copper, Cu	0·017 grm. (¼ gr.).

Paris green, aceto-arsenite of copper may be considered a combination of arsenite of copper, or Scheele's green and acetate of copper, or verdigris, thus uniting the poisonous qualities of copper salts and arsenic.

The qualitative analysis (presence of copper, acetic acid and arsenious acid) led to the conclusion that the pigment of these papers really was the above named and previously suspected substance.

The fatal dose of arsenic for an adult is from 2 to 5 grains; a dose of half a grain, however (as contained in one paper of the above size), will already produce severe symptoms of poisoning; the medicinal dose, according to the "U. S. Dispensary," being $\frac{1}{10}$ to $\frac{1}{15}$ of a grain for an adult.

The poisonous pigment is made to adhere to the paper by a simple mechanical process—the adhesion is but very slight, and friction, as well as moisture, will loosen entirely. If such candy is given to children, particularly to small ones, who may take the colored paper in the mouth, or handle it with wet hands, they are in danger of being poisoned.

It is difficult to understand how people can be so devoid of conscience and reckless to employ for such a purpose such dangerous paper, or if it is ignorance, is it excusable? Is such a practice too trifling a matter for the Boards of Health to notice?

Otto, the eminent German toxicologist, mentions a case where two children lost their lives through a Christmas present—a toy painted with Paris green. The danger is still greater if eatables are enclosed in such poisonous paper.

It would be superfluous to dwell on the dangerousness of wall paper, lamp shades, artificial flowers, fancy letter paper, gauze, etc., colored with Paris green; but it should be considered a duty to humanity to direct the attention of the public to such facts like the above.—*American Journal of Pharmacy.*

CLARIFIED HONEY.

THIS is obtained by E. Dannenberg, of unexceptionable quality, by diluting the crude honey with half its weight of water, boiling for 15 or 30 minutes, according to the quantity operated upon, the scum being carefully removed, and then adding five or six times sufficient cold water to interrupt the boiling for not over half a minute. After boiling for another 15 minutes, the hot honey is strained and evaporated. Thus prepared, the author has kept the honey unaltered for over two years.—*Archiv d. Phar.*

REMEDIES AGAINST WORMS AND INSECTS.

THE insect question is a very important one; they will destroy us if we don't destroy them. The following modes I use as occasion demands, and never fail:

Melon and cucumber bugs like radish leaves better than any other kind. I sow a few radish seeds in each hill, and *never lose a plant*. Earth-worms, cut-worms, white grubs, and, in fact, all *soft-bodied worms*, are easily driven out by *salt* sown broadcast. You can do no harm with ten bushels to the acre, but a half bushel is ample. Dry slacked lime is also effectual. Potato-bugs find their "anti" in Paris green—one tablespoonful, flour ten spoonfuls; water, one bucket; mix and *keep mixed*, as the Paris green settles; apply with a watering pot.

For cabbage-worms apply dry salt if the plants are wet, or strong brine if they are dry.

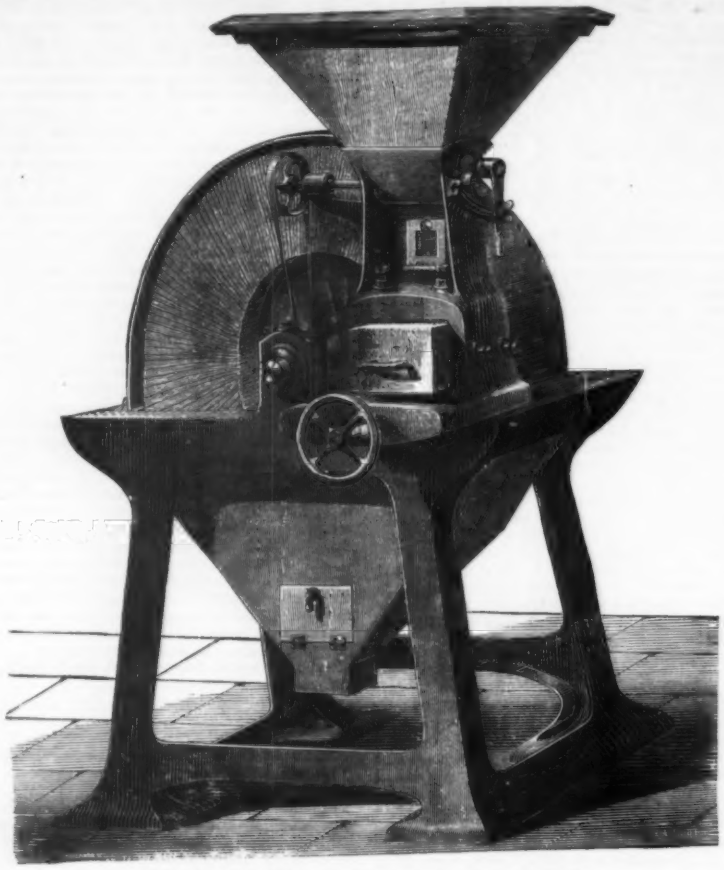
Turnip flies are destroyed by fine slacked lime, dusted over the field.

But the whole tribe of depredators are wonderfully kept down by *making friends with the birds*. They are the natural enemies of all insects, worms, grubs, etc.

In fighting vermin, we must not try to oppose Nature, but to rather follow her plans, and assist her if she fails.—*Canada Farmer*.

NEW GRAIN CRUSHER.

A NOVEL construction of grain crushing machine, worked by hand, is shown in the illustration. It is the design of Von Hörde & Co., Vienna. It consists of a housed ring-shaped stone, that is dressed at the side face with nearly radial furrows, and supported on a horizontal shaft, turning in bearings of a suitable frame. The crushing of the grain, etc., is accomplished by the passage of the same between the revolving stone and a horizontally guided and adjustable segment, that is set nearer to or further from the face of the stone by a screw with hand-wheel, being then firmly clamped into position by side screws. The grain is fed by means of a hopper, with bottom feed roller revolved in connection with the shaft of the stone. The feed opening of the hopper may be enlarged or diminished by a swinging and adjustable feed plate. A uniform quantity of grain is fed to the stones, and dropped regularly in a crushed state. The crusher is adapted for the breaking of grain, oats, rye, barley, corn, and other articles used as feed to horses and cattle, and also for breaking malt in breweries. One of the advantages of the machine consists in the fact that the crushing stone and segment may never be brought so close together as to come in contact during the running of the crusher. The machine produces the crushing of the substances, passed through the same, with but little, if any, forming of flour.



HAND-POWER GRAIN CRUSHER.

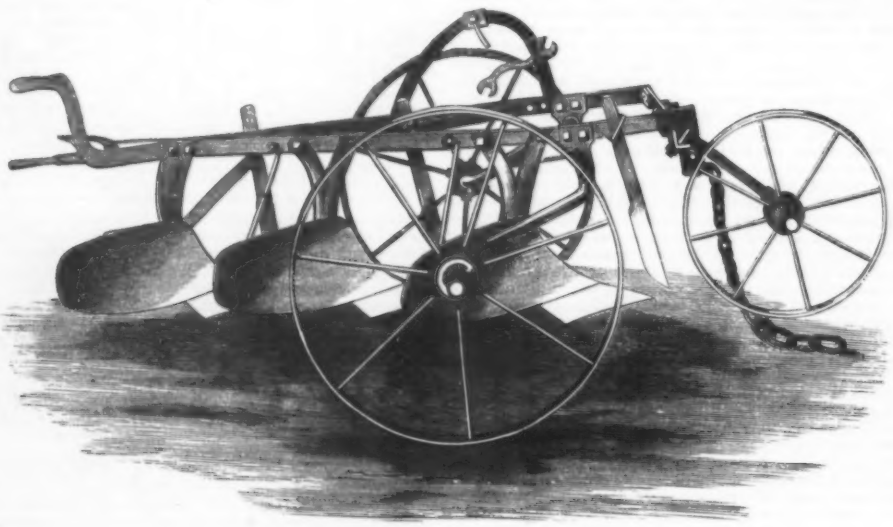
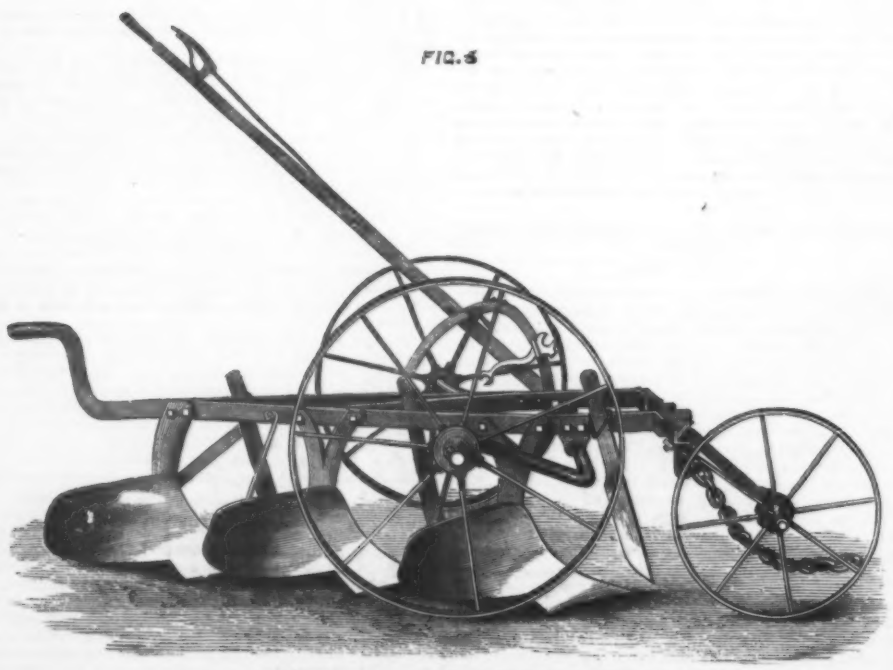


FIG. 3



RANSOME'S THREE-FURROW PLOW.

ENGLISH THREE-FURROW PLOWS.

AT the recent Smithfield Club Show, Messrs. Ransomes, Sims & Head exhibited their three furrow plough, which we illustrate. Used with eight horses ploughing a width of 40 in. on medium soil, and turning in a day of ten hours a surface of four and a half to six and a quarter acres, or four times the work accomplished by a good Brabant plough drawn by three horses; effecting thus a saving of three men and four horses. The same implement is made with either two, three, or four furrows; the three furrow, however, being most used. Its construction, lightness, strength, and facility of turning, and moving from field to field, have been the great points aimed at; and the lines on which multiple ploughs have been previously built are quite departed from. The frame is triangular in shape, and light in appearance; but is amply strong enough to contend with the heaviest work. To this frame the three skifes carrying the breasts are securely bolted, by means which allow an adjustment of the pitch of the shares, and insure at the same time perfect rigidity in work. The plough is carried on two large wheels placed outside of the frame, one of which, when in work, serves as a land wheel, the other, set to run a few inches higher, being then quite idle, and just touching the surface of the ploughed land. Attached at a fixed angle to the cranked axle which carries these wheels, is a lever, by means of which they can be depressed and raised at pleasure, enabling the plough to be raised on them above the ground a clear 7 in., thus facilitating its transport from field to field, and the depth of work may be regulated with accuracy. The latter operation is effected by means of a movable clip fixed on an arc on the beam, and a spring catch worked from the handle of the lever by which the position of the handle upon the arc is fixed by the ploughman at the commencement of each furrow. This adjustment ranges from 2 in. to 7 in. The plough is manufactured throughout of wrought iron and steel, and weighs but a little over 4 cwt. It combines great strength with simplicity, and permits economy in men and tractive power.

FERTILIZING INFLUENCE OF SNOW.

SNOW is often called the "poor man's manure," and if it is true that it has any manurial value the farmer's prospects for the next season are certainly flattering. The body of snow upon the ground in all the Northern and Middle States is very great, and millions of acres of land are covered by it, as with a blanket of the whitest wool. It is probable that seldom, perhaps never, has so wide an area of our country been covered as during this month of January, 1877. The question whether snow is capable of affording to lands any of the elements of fertility is one often asked, and in reply it may be said that it probably is. The atmosphere holds ammonia and some other nitrogenous products, which are undoubtedly brought to the soil by snowflakes as well as by rain drops. Experience both here and abroad would seem to prove the truth of this conclusion. Rains are not only valuable for the moisture which they supply, but for what they bring to us from the atmosphere. During a thunderstorm nitric acid is produced in considerable quantities, and, dissolved in the rain drops to a high degree of attenuation, its effects upon soils are highly salutary.—*Boston Jour. of Chemistry.*

AGRICULTURAL labor in this country is the source of our great national wealth. Think of one crop, that of cotton, giving us the enormous sum of $300,000,000 in cash each year; also look at our corn and wheat crops, which bring to us fabulous sums of money.

FOR adorning and beautifying the home, there is no plant that can be so readily used for hanging-basket or "box of green" as the fern. They can be hung or placed anywhere in the shaded nooks and corners of the house; can be had in the woods and raised without difficulty, if you cut off the whole of the foliage.

ICE HOUSE AND COLD ROOMS.

WE have procured from Mr. R. G. Hatfield, architect, of No. 31 Pine street, in this city, plans of an ice house erected by him some time since, which will probably serve the purposes of several of our enquiring correspondents, and which has certainly been well tested, having preserved its store of ice for two years at a time. This ice house having been erected for the use of a public building, its size is perhaps greater than would be necessary on an ordinary farm, but its dimensions may be altered to suit circumstances if the proportion of the different parts be very nearly adhered to.

The ice room is 16 by 15 feet and 12 feet high in the clear. The cold room under the ice room, is of the same size as the latter on the floor, and 7 feet 6 inches high in the clear. In addition to the cold room below, there are two apartments or passages surrounding the ice room which serve the two-fold purpose of preserving the ice from the exterior heated air, and giving additional room for cold storage. The width of these enclosing passages is 4 feet, and their heights are 8 feet and 9 feet 6 inches respectively. They are sufficiently wide for a series of shelves upon one side of each throughout, which gives a very useful extent of shelving room.

The entrance to these apartments is by the door shown in the elevation, Fig. 1, and at A, Fig. 3. The ice is received at a high door at B and C, Figs. 2 and 4. At D and E, Figs. 2 and 3, are windows to light the passages, etc., and at F,

FIG. 1.

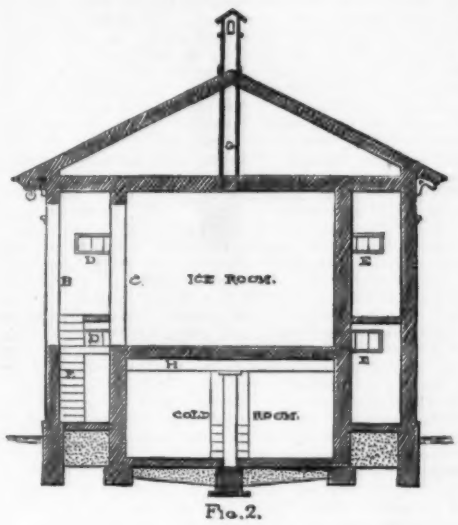


FIG. 2.

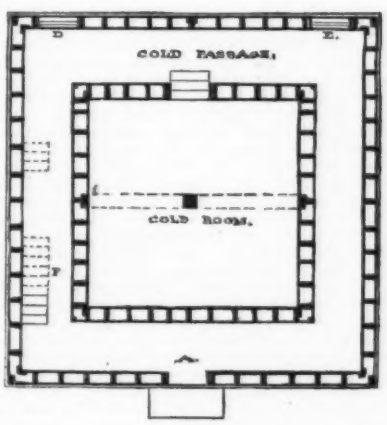


FIG. 3

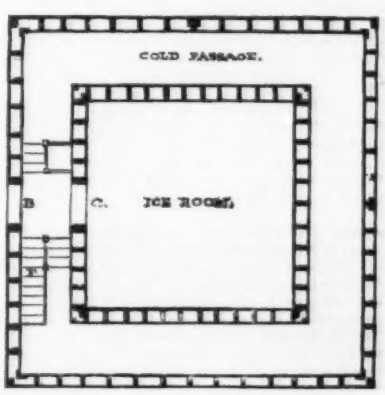


FIG. 4.

ICE HOUSE AND COLD ROOM.

Figs. 2, 3, and 4, are placed the stairs by which access is obtained to the ice room and to the upper part of the enclosing space. The studding of the interior frame is 3 by 12 inches, that of the exterior frame is 3 by 10 inches, and the spaces between the studding are filled with saw-dust. The space under the lower floor is filled with wood shavings. The floor and ceiling joists also have their spaces filled with saw-dust. At G, Fig. 2, is a ventilator shaft, and at H, a girder. The window sashes are double, and the doors have canvas linings packed with saw-dust, to make them of the thickness of the frame. The excavation is about 2 feet below the surface. The plans are drawn at a scale of 8 feet to the inch. A drain was provided extending from the center of the building under the lower floor to the sewer and trapped.

THE CATALPA TREE.

WE find in the *Railway Age* several letters showing the value of this wood to the mechanic, and indirectly the advantage which it would be to our tree planters to grow it:

In the spring of 1871, in conversation with Wm. R. Arthur, formerly superintendent of the Illinois Central Railroad, he stated that catalpa ties would last for ever; that it was easily cultivated, was of rapid growth, and when planted in groves grew straight and tall as any forest tree; that he had several groves then growing on his farm that had been planted but four years, and were 20 to 30 feet high; that he had planted them for fence posts, but had subsequently learned that they would hold a spike as well as oak, and would not split. Hence their value for cross-ties.

Three years ago I cut from a catalpa tree, that had been cut down after growing 30 years as a shade tree, two railroad cross-ties, and placed them in a track over which trains pass every hour, one under a rail joint. The spikes show no signs of loosening. The catalpa does not hold a spike as well as oak, but sufficiently well for all practical purposes. It does not split easily. While not as tough as some woods, it should not be termed brittle, as stated in Millikin's essay. I subjected pieces of catalpa, oak and ash, one inch square, to a breaking pressure twelve inches between supports. The catalpa broke under a pressure of 703 pounds; ash 896 pounds; one piece of oak at 577, one at 709, and one at 1,141 pounds. The catalpa deflected three times as much as the oak or ash before breaking.

This handsome and valuable tree is native in all the south-western States, but is everywhere rare. It is distinguished by its silver-grey, slightly furrowed bark, its wide-spreading head, the fewness of its branches, and the fine pale green of its very large heart-shaped leaves. It is a very profuse bloomer except in wet summers. The flowers are very showy, large, bell-shaped, white, slightly tinged with violet, and dotted with purple in the throat. They are succeeded by long bean-shaped seed pods, which hang till the next spring, when they open, and the small, thin, broadly-winged seeds are borne away on the winds. The "Farmers' and Planters' Encylopedia" says the rapid growth of the catalpa in almost every situation in which it can be placed in the Middle States, and the adaptation of its wood to fence posts and other useful purposes, make it deserving the attention of farmers. The wood, though light, is very compact, of fine texture, and susceptible of the most brilliant polish, its fine straw color producing a fine effect in cabinet work and inside finish for houses.

Those wishing to propagate the catalpa should gather the seed pods this or next month; put in a dry place secure from mice. They may be found hanging from the catalpa tree, planted as a shade tree in most of the cities and towns in Ohio. There are fifty or more seeds in each pod. Plant in spring, in good soil, in rows three or four feet apart, six inches in the row, and thin down to one foot. Keep the ground clean, and let them grow three years; then transplant, placing them in rows ten feet apart north and south, and six feet apart east and west. In from six to eight years remove each alternate tree in rows running north and south for fence posts and telegraph poles, leaving the remaining trees ten feet apart one way and twelve the other, 363 to the acre. In from six to eight years more these will be large enough to make four to eight railroad ties each, if they have been planted in good ground. They should be split or sawed through the middle and the round side placed on the ground. The catalpa has only a film of sap one-sixteenth inch thick.

Each acre and a half of ground, thus planted and properly cared for, will furnish enough fence posts and telegraph poles in from eight to twelve years to pay for the land and all expense of planting, care and protection, and in from fifteen to eighteen years furnish railroad ties for one mile of track, which at fifty cents each (cheap, considering their quality), will pay $50 per year on each acre of ground for each year they have been growing. Can a farmer make a better investment for himself and family than to plant ten or twelve acres in catalpa trees? A railroad once tied with catalpa would find its annual expenses for repairs diminished $200 per mile, a saving that would add 10 per cent. to the value of the property.

THE ABSORPTION OF ORGANIC MATTER BY PLANTS.

IN a communication from Prof. Calderon, of the Institute of Las Palmas, Canary Isles, he contests the ordinary view that the nitrogen of the tissues of plants is derived entirely from the nitrates and ammoniacal salts absorbed through the roots. He does not, however, adopt the old theory that the source is the free nitrogen of the atmosphere, but rather the nitrogenous organic matter which is always floating in the air. The nutrition of plants he divides into three classes: *necrophagous*, the absorption of dead organic matter in various stages of decomposition; *plasmophagous*, the assimilation of living organic matter without elimination, or distinction of any kind between useful and useless substances, such as the nutrition of parasites; and *biophagous*, the absorption of living organisms, such as that known in the case of insectivorous plants. A further illustration of the latter kind of nutrition is, according to Prof. Calderon, furnished by all plants provided with viscid hairs or a glutinous excretion, the object of which is the detention and destruction of small insects. To prove the importance of the nitrogenous substances floating in the air to the life of plants, he deprived air of all organic matter in the mode described by Professor Tyndall, and subjected lichens to the access only of this filtered air and of distilled water, when he found all their physiological functions to be suddenly suspended.—*Nature.*

A RUSSIAN WOLF TRAP.

AT *a* is a door, by which Mr. Isegrim, the wolf, is apt to enter, enticed to do so by a goat, which is put into an inner enclosure, *c*. The wolf walks along *b*, *b*, *b*, arrives at *d*, which is a gate. Now, as he does not like to turn round, he pushes against *d*, which will close up *a*, *a*, and be caught. Mr. Isegrim, sly as he is, is also very straightforward; he will not turn, he will run on, and whenever he arrives at *d*

(which, perhaps, the wind may have thrown open again) he will push against it and shut it up again. Thus the night passes, and in the morning Isegrim is found and strangled with a sling, for to shoot him would not be advisable, as his "sweat" would keep off his kin. All this while the goat has been eating bean straw in her safe enclosure.

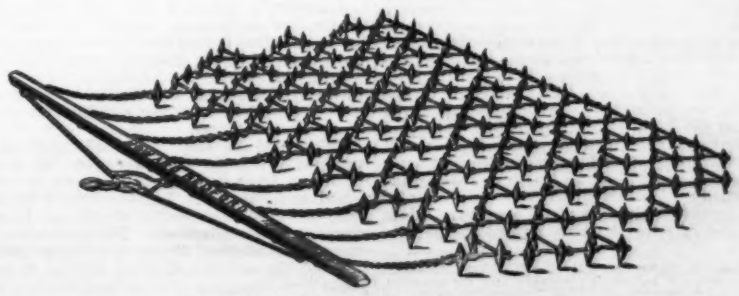
The month when wolves are particularly apt to walk into this Circean castle is the month of August, when they have to find tender food for their puppies; but they are caught all the year round, always in one and the same trap, which thus is the very best way to invest a few dozens of poles some 4 feet high, and it will be best not even to peel them.

KEEPING CIDER AND APPLES.

A CORRESPONDENT of the Elmira Farmers' Club says: If your members wish to keep cider fresh and nice as new, they will succeed by doing as follows: Take the cider fresh from the press, heat it to a boiling point and skim, then bottle and seal up hot. It can be put in jugs or casks. I have put it up so for the past five years, and find it to improve with age. A word about saving your apples. You can have fresh apples by packing them in dry hemlock saw-dust, as you would eggs in salt. We have them fresh until the new crop is gathered. They should be put in piles to sweat before packing.

NEW FLEXIBLE HARROW.

OUR engraving shows a new form of flexible harrow, lately introduced by Messrs. Howard, of Bedford, England. It is made on the tripod plan, united by steel rods, and is said to be very effective when in practical operation.



NEW FLEXIBLE HARROW.

THE ASCENT OF TAKHOMA.

DISCOVERY OF CAVERNS WITHIN THE CRATER OF THE VOLCANO.

THE following remarkable account of the ascent of Mt. Rainier, or Takhoma, in Washington Territory, we condense from a recent number of the *Atlantic Monthly*. It is from the pen of Mr. Hazard Stevens, who was the originator of the expedition:

When Vancouver, in 1792, penetrated the Straits of Fuca and explored the unknown waters of the Mediterranean of the Pacific, wherever he sailed, from the Gulf of Georgia to the farthest inlet of Puget Sound, he beheld the lofty, snow-clad barrier range of the Cascades stretching north and south and bounding the eastern horizon. Towering at twice the altitude of all others, at intervals of a hundred miles, there loomed up above the range three majestic, snowy peaks that—

"Like giants stand
To sentinel enchanted land."

In the matter-of-fact spirit of a British sailor of his time, he named these sublime monuments of nature in honor of three lords of the English admiralty, Hood, Rainier, and Baker. Of these Rainier is the central, situated about half-way between the Columbia River and the line of British Columbia, and is by far the loftiest and largest. Its altitude is 14,444 feet, while Hood is 11,025 feet, and Baker is 10,810 feet high. The others, too, are single cones, while Rainier or Takhoma,* is an immense mountain mass with three distinct peaks, an eastern, a northern, and a southern; the two last extending out and up from the main central dome, from the summit of which they stand over a mile distant, while they are nearly two miles apart from each other.

Takhoma overlooks Puget Sound from Olympia to Victoria, one hundred and sixty miles. Its snow-clad dome is visible from Portland on the Willamette, one hundred and twenty miles south, and from the table land of Walla Walla, one hundred and fifty miles east. A region two hundred and fifty miles across, including nearly all of Washington Territory, part of Oregon, and part of Idaho, is commanded in one field of vision by this colossus among mountains.

Takhoma had never been ascended. It was a virgin peak. The superstitious fears and traditions of the Indians, as well as the dangers of the ascent, had prevented their attempting to reach the summit, and the failure of a gallant and energetic officer, whose courage and hardihood were abundantly shown during the rebellion, had in general estimation proved it insurmountable.

For two years I had resolved to ascend Takhoma, but both seasons the dense smoke overspreading the whole country had prevented the attempt. Mr. Philomon Beecher Van Trump, humorous, generous, whole souled, with endurance and experience withal, for he had roughed it in the mines, and a poetic appreciation of the picturesque and the sublime, was equally eager to scale the summit. Mr. Edward T. Coleman, an English gentleman of Victoria, a landscape artist and an Alpine tourist, whose reputed experience in Switzerland had raised a high opinion of his ability above the snow line, completed the party.

Olympia, the capital of Washington Territory, is a beautiful, maple embowered town of some two thousand inhabitants, situated at the southernmost extremity of Puget Sound, and west of Takhoma, distant in an air line seventy-five miles. The intervening country is covered with dense fir forests, almost impenetrable to the midday sun, and obstructed with fallen trees, upturned roots and stumps, and a perfect jungle of undergrowth, through which the most energetic traveler can accomplish but eight or nine miles a day. It was advisable to gain the nearest possible point by some trail before plunging into the unbroken forest. The Nisqually River, which rises on the southern and western slopes of Takhoma and empties into the Sound a few miles north of Olympia, offered the most direct and natural approach. Ten years before, moreover, a few enterprising settlers had blazed out a trail across the Cascade Range, which followed the Nisqually nearly up to its source, thence deflected south to the Cowlitz River, and pursued this stream in a northeastern course to the summit of the range, thus turning the great mountain by a wide circuit. The best informed mountain men represented the approaches on the south and southeast as by far the most favorable. The Nisqually-Cowlitz trail, then, seemed much the best, for the Nisqually, heading in the south and southwest slopes, and the Cowlitz, in the southeastern, afforded two lines of approach, by either of which the distance to the mountain, after leaving the trail, could not exceed thirty miles.

We applied to Mr. Longmire for a guide, and for his advice as to our proposed trip. He was one of the few who marked out the Nisqually-Cowlitz trail years ago. He had explored the mountains about Takhoma as thoroughly, perhaps, as any other white man. One of the earliest settlers, quiet, self-reliant, sensible and kindly, a better counsellor than he could not have been found. The trail, he said, had not been travelled for four years, and was entirely illegible to eyes not well versed in woodcraft, and it would be folly for any one to attempt to follow it who was not thoroughly acquainted with the country.

Early in the morning Mr. Longmire arrived in camp with two mules and a pack horse, and our mountain outfit was rapidly made up into suitable bales and packed upon the horse and one of the mules, the other mule being reserved for Longmire's own riding.

We stepped off briskly, following a dim trail in an easterly course, and crossing the little prairie entered the timber. After winding over hilly ground for about three miles, we descended into the Nisqually bottom and forded a fine brook at the foot of the hill. For the next ten miles our route lay across the bottom, and along the bank of the river, passing around logs, following old, dry beds of the river and its lateral sloughs, ankle deep in loose sand, and forcing our way through dense jungles of vine maple. The trail was scarcely visible, and much obstructed by fallen trees and underbrush, and its difficulties were aggravated by the bewildering tracks of Indians who had lately wandered about the bottom in search of berries or rushes. We repeatedly missed the trail, and lost hours in retracing our steps and searching for the right course. The weather was hot and sultry, and rendered more oppressive by the dense foliage; myriads of gnats and mosquitoes tormented us and drove our poor animals almost frantic; and our thirst, aggravated by the severe and unaccustomed toil, seemed quenchless. At length we reached the ford of the Nisqually. Directly opposite, a perpendicular bluff of sand and gravel in alternate strata rose to the height of two hundred and fifty feet, its base washed by the river and its top crowned with firs. The stream was a hundred yards wide, waist deep, and very rapid. Its waters were icy cold, and of a milk-white hue. This color is the characteristic of glacial rivers. The impalpable powder of thousands of tons of solid rocks, ground up beneath the vast weight and resistless, though imperceptible, flow of huge glaciers, remains in solution in these streams, and colors them milk-white to the sea.

After four days of incredible toil, scrambling through forests filled with underbrush and thickets, over fallen trees and jagged rocks, half submerged at times in icy snow water from the great peaks above, our travellers left Nisqually. Turning to the right and travelling in a southerly course, we followed up the bed of a swampy creek for half a mile, then crossed a level tract much obstructed with fallen timber, then ascended a burnt ridge, and followed it for two miles to a small, marshy prairie in a wide canyon or defile closed in by rugged mountains on either side, and camped beside a little rivulet on the east side of the prairie. This was Bear Prairie, the altitude of which by the barometer was 2,630 feet. The canyon formed a low pass between the Nisqually and Cowlitz rivers, and the little rivulet near which we camped flowed into the latter stream. The whole region had been swept by fire; thousands of giant trunks stood blackened and lifeless, the picture of desolation.

As we were reclining on the ground around the camp fire, enjoying the calm and beatific repose which comes to the toil-worn mountaineer after his hearty supper, one of these huge trunks, after several warning creaks, came toppling and falling directly over our camp. All rushed to one side or another to avoid the impending crash. As one member of the party, hastily catching up in one hand a frying pan laden with tin plates and cups, and in the other the camp kettle half full of boiling water, was scrambling away, his foot tripped in a blackberry vine and he fell outstretched at full length, the much prized utensils scattering far and wide, while the falling tree came thundering down in the rear, doing no other damage, however, than burying a pair of blankets.

The following day Longmire and the writer went down the canyon to its junction with the Cowlitz River, in search of a band of Indians who usually made their headquarters at this point, and among whom Longmire hoped to find some hunter familiar with the mountains who might guide us to the base of Takhoma. The tiny rivulet as we descended soon swelled to a large and furious torrent, and its bed filled nearly the whole bottom of the gorge. The mountains rose on both sides precipitously, and traces of land slides which had gorged vast furrows down their sides were frequent. With extreme toil and difficulty we made our way, continually wading the torrent, clambering over broken masses of rock which filled its bed, or clinging to the steep hill sides, and reached the Cowlitz at length after twelve miles of this fatiguing work, but only to find the Indian camp deserted. Further search, however, was rewarded by the discovery of a rude shelter formed of a few skins thrown over a framework of poles, beneath which sat a squaw at work upon a half dressed deerskin. An infant and a naked child of perhaps four years lay on the ground near the fire in front. Beside the lodge and quietly watching our approach, of which he alone seemed aware, stood a tall, sinewy Indian clad in buckskin shirt and leggings, with a striped woollen breech clout, and a singular head garniture which gave him a fierce and martial appearance. This consisted of an old military cap, the visor thickly studded with brass-headed nails, while a large circular brass article, which might have been the top of an oil lamp, was fastened upon the crown. Several eagle feathers stuck in the crown and strips of fur sewed upon the sides completed the edifice, which, notwithstanding its components, appeared imposing rather than ridiculous. A long Hudson Bay gun, the stock also ornamented with brass-headed tacks, lay in the hollow of the Indian's shoulder.

He received us with great friendliness, yet not without dignity, shaking hands and motioning us to a seat beneath the rude shelter, while his squaw hastened to place before us suspicious-looking cakes of dried berries, apparently their only food. After a moderate indulgence in this delicacy, Longmire made known our wants. The Indian spoke fluently the Chinook jargon, that high bred lingo invented by the old fur traders. He called himself "Sluiskin" and readily agreed to guide us to Rainier, known to him only as Takhoma, and promised to report at Bear Prairie the next day. It was after seven in the evening when we reached camp thoroughly fagged.

Punctual to promise, Sluiskin rode up at noon mounted upon a stunted Indian pony, while his squaw and pappooses followed upon another even more puny and forlorn. After devouring an enormous dinner, evidently compensating for the rigors of a long fast, in reply to our inquiries he described the route he proposed to take to Takhoma. Pointing to the almost perpendicular height immediately back or east of our camp, towering three thousand feet or more overhead, the loftiest mountain in sight, "We go to the top of that mountain to-day," said he, "and to-morrow we follow along the high, backbone ridges of mountains, now up, now down, first on one side and then on the other, a long day's journey, and at last, descending far down from the mountains into a deep valley, reach the base of Takhoma." Sluiskin illustrated his Chinook with speaking signs and pantomime. He had frequently hunted the mountain sheep upon the snow fields of Takhoma, but had never ascended to the summit. It was impossible to do so, and he put aside as idle talk our expressed intention of making the ascent.

We had already selected the indispensable articles for a week's tramp, a blanket apiece, the smallest coffee pot and frying pan, a scanty supply of bacon, flour, coffee, etc., and had made them up into suitable packs of forty pounds each, provided with slings like a knapsack, and had piled together under the lee of a huge fallen trunk our remaining goods. Longmire, who although impatient to return home, where his presence was urgently needed, had watched and directed our preparations during the forenoon with kindly solicitude, now bade us good-by; mounted on one mule and leading the other, he soon disappeared down the trail on his lonely homeward way. He left us the little packhorse, thinking it would be quite capable of carrying our diminished outfit after our return from Takhoma.

Sluiskin led the way. The load upon his shoulders was sustained by a broad band passing over his head, upon which his heavy, brass-studded rifle, clasped in both hands, was poised and balanced. Leaving behind the last vestige of trail, we toiled in single file slowly and laboriously up the mountain all the afternoon. The steepness of the ascent in many places required the use of both hand and foot in climbing, and the exercise of great caution to keep the heavy packs from dragging us over backwards. Coleman lagged behind from the start, and at intervals his voice could be heard hallooing and calling upon us to wait. Towards sunset we reached a level terrace or bench near the summit, gladly threw off our packs, and waited for Coleman, who, we supposed, could not be far below. He not appearing, we hallooed again and again. No answer! We then sent Sluiskin down the mountain to his aid. After an hour's absence the Indian returned. He had descended, he said, a long distance, and at last caught sight of Coleman. He was near the foot of the mountain, had thrown away his pack, blankets and all, and was evidently returning to camp. And Sluiskin finished his account with expressions of contempt for the "cultus King George man." What was to be done? Coleman carried in his pack all our bacon, our only supply of meat, except a few pounds of dried beef. He also had the barometer, the only instrument that had survived the jolts and tumbles of our rough trip. But, on the other hand, he had been a clog upon our march from the outset. He was evidently too infirm to endure the toil before us, and would not only be unable to reach, still less to ascend, Takhoma, but might even impede and frustrate our own efforts. Knowing that he would be safe in camp until our return, we hastily concluded to proceed without him, trusting to our rifles for a supply of meat.

Sluiskin led us along the side of the ridge in a southerly direction for two miles farther, to a well sheltered, grassy hollow in the mountain top, where he had often previously encamped. It was after dark when we reached this place. The usual spring had gone dry, and, parched with thirst, we searched the gulches of the mountain side for water an hour, but without success. At length the writer, recalling a scanty rill which trickled across their path a mile back, taking the coffee pot and large canteen, retraced his steps, succeeded in filling these utensils after much fumbling in the dark and consequent delay, and returned to camp. He found Van Trump and the Indian, anxious at the long delay, mounted on the crest of the ridge some 200 yards from camp, waving torches and shouting lustily to direct his steps. The mosquitoes and flies came in clouds, and were terribly annoying. After supper of coffee and bread, we drank up the water, rolled ourselves in our blankets, and lay down under a tree with our flags floating from the boughs overhead. Hot as had been the day, the night was cold and frosty, owing, doubtless, to the altitude of our camp.

At the earliest dawn next morning we were moving on without breakfast and parched with thirst. Sluiskin led us in a general course about north-northeast, but twisting to nearly every point of the compass, and climbing up and down thousands of feet from mountain to mountain, yet keeping on the highest backbone between the head waters of the Nisqually and Cowlitz rivers. After several hours of this work we came to a well sheltered hollow, one side filled with a broad bed of snow, at the foot of which nestled a tiny, tranquil lakelet, and gladly threw off our heavy packs, assuaged our thirst, and took breakfast—bread and coffee again. Early as it was, the chill of the frosty night still in the air, the mosquitoes renewed their attacks, and proved as innumerable and vexatious as ever.

Continuing our march, we crossed many beds of snow, and drank again and again from the icy rills which flowed out of them. The mountains were covered with stunted mountain ash and low, stubby firs with short, bushy branches, and occasionally a few pines. Many slopes were destitute of trees, but covered with luxuriant grass and the greatest profusion of beautiful flowers of vivid hues. This was especially the case with the southern slopes, while the northern sides of the mountains were generally wooded. We repeatedly ate berries, and an hour afterwards ascended to where berries of the same kind were found scarcely yet formed. The country was much obscured with smoke from heavy fires which had been raging on the Cowlitz the last two days. But when at length, after climbing for hours an almost perpendicular peak—creeping on hands and knees over loose rocks, and clinging to scanty tufts of grass where a single slip would have sent us rolling a thousand feet down to destruction—we reached the highest crest and looked over, we exclaimed that we were already well repaid for all our toil. Nothing can convey an idea of the grandeur and ruggedness of the mountains. Directly in front, and apparently not over two miles distant, although really twenty, old Takhoma loomed up more gigantic than ever. We were far above the level of the lower snow line on Takhoma. The high peak upon which we clung seemed the central core or focus of all the mountains around, and on every side we looked down vertically thousands of feet, deep down into vast, terrible defiles, black and fir clothed, which stretched away until lost in the distance and smoke. Between them, separating one from another, the mountain walls rose precipitously and terminated in bare columnar peaks of black basaltic or volcanic rock, as sharp as needles. It seemed incredible that any human foot could have followed out the course we came, as we looked back upon it.

After a few hours more of this climbing, we stood upon the summit of the last mountain ridge that separated us from Takhoma. We were in a saddle of the ridge; a lofty peak rose on either side. Below us extended a long, steep hollow or gulch filled with snow, the farther extremity of which seemed to drop off perpendicularly into a deep valley or basin. Across this valley, directly in front, filling up the whole horizon and view with an indescribable aspect of magnitude and grandeur, stood the old leviathan of mountains. The broad, snowy dome rose far among and above the clouds. The sides fell off in vertical steeps and fearful black walls of rock for a third of its altitude; lower down, vast, broad, gently sloping snow fields surrounded the mountain, and were broken here and there by ledges or masses of the dark basaltic rock protruding above them. Long, green ridges projected from this snow belt at intervals, radiating from the mountain and extending many miles until lost in the distant forests. Deep valleys lay between these ridges. Each at its upper end formed the bed of a glacier, which closed and filled it up with solid ice. Below the snow line bright green grass with countless flowers, whose vivid scarlet, blue and purple formed bodies of color in the distance, clothed the whole region of ridges and valleys, for a breadth of five miles. The beautiful balsam firs, about thirty feet in height, and of a purple, dark green color, stood scattered over the landscape, now singly, now in groves, and now in long lines, as though planted in some well kept park. Farther down an unbroken fir forest surrounded the mountain and clad the lower portions of the ridges and valleys. In every sheltered depression or hollow lay beds of snow with tiny brooks and rivulets flowing from them. The glaciers terminated not gradually, but abruptly, with a wall of ice from one to five hundred feet high, from beneath which yeasty torrents burst forth and rushed roaring and tumbling down the valleys. The principal of these, far away on our left front, could be seen plunging over two considerable falls, half hidden in the forest, while the roar of waters was distinctly audible.

At length we cautiously descended the snow bed, and, climbing at least fifteen hundred feet down a steep but an-

* Tak-ho'ma or Taho'ma among the Yakimas, Klikitats, Puyallups, Nisqually's, and allied tribes of Indians, is the generic term for mountain, used precisely as we use the word "mount," as Takhoma Wynatchie, or Mount Wynatchie. But they all designate Rainier simply as Takhoma, or The Mountain, just as the mountain men used to call it the "Old He."

cient land slide by means of the bushes growing among the loose rocks, reached the valley, and encountered a beautiful, peaceful, limpid creek. Van Trump could not resist the temptation of unpacking his bundle, selecting one of his carefully preserved flies, and trying the stream for trout, but without a single rise. After an hour's rest and a hearty repast we resumed our packs, despite Sluiskin's protests, who seemed tired out with his arduous day's toil and pleaded hard against travelling farther. Crossing the stream, we walked through several grassy glades or meadows, alternating with open woods. We soon came to the foot of one of the long ridges already described, and ascending it followed it for several miles through open woods, until we emerged upon the enchanting emerald and flowery meads which clothe these upper regions. Halting upon a rising eminence in our course, and looking back, we beheld the ridge of mountains we had just descended stretching from east to west in a steep, rocky wall; a little to the left, a beautiful lake, evidently the source of the stream just crossed, which we called Clear Creek, and glimpses of which could be seen among the trees as it flowed away to the right, down a rapidly descending valley along the foot of the lofty mountain wall. Beyond the lake again, still farther to the left, the land also subsided quickly. It was at once evident that the lake was upon a summit, or divide, between the waters of the Nisqually and Cowlitz rivers. The ridge which we were ascending lay north and south, and led directly up the mountain.

We camped, as the twilight fell upon us, in an aromatic grove of balsam firs. A grouse, the fruit of Sluiskin's rifle, broiled before the fire and impartially divided, gave a relish to the dry bread and coffee. After supper we reclined upon our blankets in front of the bright, blazing fire, well satisfied. The Indian, when starting from Bear Prairie, had evidently deemed our intention of ascending Takhoma too absurd to deserve notice. The turning back of Mr. Coleman only deepened his contempt for our prowess. But his views had undergone a change with the day's march. The affair began to look serious to him, and now in Chinook, interspersed with a few words of broken English and many signs and gesticulations, he began a solemn exhortation and warning against our rash project.

Takhoma, he said, was an enchanted mountain, inhabited by an evil spirit, who dwelt in a fiery lake on its summit. No human being could ascend it or even attempt its ascent, and survive. At first, indeed, the way was easy. The broad snow-fields, over which he had so often hunted the mountain goat, interposed no obstacle, but above them the rash adventurer would be compelled to climb up steeps of loose, rolling rocks, which would turn beneath his feet and cast him headlong into the deep abyss below. The upper snow-slopes, too, were so steep that not even a goat, far less a man, could get over them. And he would have to pass below lofty walls and precipices whence avalanches of snow and vast masses of rock were continually failing; and these would inevitably bury the intruder beneath their ruins. Moreover, a furious tempest continually swept the crown of the mountain, and the luckless adventurer, even if he wonderfully escaped the perils below, would be torn from the mountain and whirled through the air by this fearful blast. And the awful being upon the summit, who would surely punish the sacrilegious attempt to invade his sanctuary—who could hope to escape his vengeance? Many years ago, he continued, his grandfather, a great chief and warrior, and a mighty hunter, had ascended part way up the mountain, and had encountered some of these dangers, but he fortunately turned back in time to escape destruction; and no other Indian had ever gone so far.

Finding that his words did not produce the desired effect, he assured us that, if we persisted in attempting the ascent, he would wait three days for our return, and would then proceed to Olympia and inform our friends of our death; and he begged us to give him a paper (a written note) to take to them, so that they might believe his story. Sluiskin's manner during this harangue was earnest in the extreme, and he was undoubtedly sincere in his forebodings. After we had retired to rest, he kept up a most dismal chant or dirge until late in the night. The dim, white, spectral mass towering so near, the roar of the torrents below us, and the occasional thunder of avalanches, several of which fell during the night, added to the weird effect of Sluiskin's song.

The next morning we moved two miles farther up the ridge and made camp in the last clump of trees, quite within the limit of perpetual snow. Thence, with snow-spikes upon our feet and Alpine staff in hand, we went up the snow-fields to reconnoitre the best line of ascent. We spent four hours, walking fast, in reaching the foot of the steep, abrupt part of the mountain. After carefully scanning the southern approaches, we decided to ascend on the morrow by a steep, rocky ridge that seemed to lead up to the snowy crown.

Our camp was pitched on a high knoll crowned by a grove of balsam firs, near a turbulent glacial torrent. About nine o'clock, after we had lain down for the night, the firs round our camp took fire and suddenly burst out in a vivid conflagration. The night was dark and windy, and the scene—the vast, dim outlines of Takhoma, the white snow-fields, the roaring torrent, the crackling blaze of the burning trees—was strikingly wild and picturesque.

In honor of our guide we named the cascade at our feet Sluiskin's Falls; the stream we named Glacier Creek, and the mass of ice whence it derives its source we styled the Little Nisqually Glacier.

THE ASCENT OF THE PEAK.

Before daylight the next morning, Wednesday, August 17, 1870, we were up and had breakfasted, and at six o'clock we started to ascend Takhoma. Besides our Alpine staffs and creepers, we carried a long rope, an ice axe, a brass plate inscribed with our names, our flags, a large canteen, and some luncheon. We were also provided with gloves and green goggles for snow blindness, but found no occasion to use the latter. Having suffered much from the heat of the sun since leaving Bear Prairie, and being satisfied from our late reconnoissance that we could reach the summit and return on the same day, we left behind our coats and blankets. In three hours of fast walking we reached the highest point of the preceding day's trip, and commenced the ascent by the steep, rocky ridge already described as reaching up to the snowy dome. We found it to be a very narrow, steep, irregular backbone, composed of a crumbling basaltic conglomerate, the top only, or backbone, being solid rock, while the sides were composed of loose broken rocks and *débris*. Up this ridge, keeping upon the spine when possible, and sometimes forced to pick our way over the loose and broken rocks at the sides, around columnar masses which we could not directly climb over, we toiled for five hundred yards, ascending at an angle of nearly forty-five degrees. Here the ridge connected, by a narrow neck or saddle, with a vast square rock, whose huge and distinct outline can be clearly perceived from a distance of twenty-five miles. This, like the ridge, is a conglomerate of basalt and trap, in well defined strata, and is rapidly disintegrating and continually falling in showers and even masses of rocks and rubbish, under the action of frost by night and melting snow by day. It lies imbedded in the side of the mountain, with one side and end projected and overhanging deep, terrible gorges, and it is at the corner or junction of these two faces that the ridge joined it at a point about a thousand feet below its top. On the southern face the strata were inclined at an angle of thirty degrees. Crossing by the saddle from the ridge, despite a strong wind which swept across it, we gained a narrow ledge formed by a stratum more solid than its fellows, and creeping along it, hugging close to the main rock on our right, laboriously and cautiously continued the ascent. The wind was blowing violently. We were now crawling along the face of the precipice almost in mid-air. On the right the rock towered far above us perpendicularly. On the left it fell sheer off, two thousand feet, into a vast abyss. A great glacier filled its bed and stretched away for several miles, all seamed or wrinkled across with countless crevasses. We crept up and along a ledge, not of solid, sure rock, but one obstructed with the loose stones and *débris* which were continually falling from above, and we trod on the upper edge of a steep slope of this rubbish, sending the stones at every step rolling and bounding into the depth below. Several times during our progress showers of rocks fell from the precipice above across our path, and rolled into the abyss, but fortunately none struck us.

Four hundred yards of this progress brought us to where the rock joined the overhanging edge of the vast *nève* or snow-field that descended from the dome of the mountain and was from time to time, as pressed forward and downward, breaking off in immense masses, which fell with a noise as of thunder into the great canyon on our left. The junction of rock and ice afforded our only line of ascent. It was an almost perpendicular gutter, but here our ice axe came into play, and by cutting steps in the ice and availing ourselves of every crevice or projecting point of the rock, we slowly worked our way up two hundred yards higher. Falling stones were continually coming down, both from the rock on our right and from the ice in front, as it melted and relaxed its hold upon them. Mr. Van Trump was hit by a small one, and another struck his staff from his hands. Abandoning the rock, then, at the earliest practicable point, we ascended directly up the ice, cutting steps for a short distance, until we reached ice so corrugated, or drawn up in sharp pinnacles, as to afford a foothold. These folds or pinnacles were about two or three feet high, and half as thick, and stood close together. It was like a very violent chop sea, only the waves were sharper. Up this safe footing we climbed rapidly, the side of the mountain becoming less and less steep, and the ice waves smaller and more regular, and, after ascending about three hundred yards, stood fairly upon the broad dome of mighty Takhoma. It rose before us like a broad gently swelling headland of dazzling white, topped with black, where the rocky summit projected above the *nève*. Ascending diagonally towards the left, we continued our course. The snow was hard and firm under foot, crisp and light for an inch or two, but solidified into ice a foot or less beneath the surface. The whole field was covered with the ice waves already described, and intersected by a number of crevasses which we crossed at narrow places without difficulty. About half-way up the slope, we encountered one from eight to twenty feet wide and of profound depth. The most beautiful, vivid emerald-green color seemed to fill the abyss, the reflection of the bright sunlight from side to side of its pure ice walls. The upper side or wall of the crevasses was some twelve feet above the lower, and in places overhung it, as though the snow-field on the lower side had bodily settled down a dozen feet. Throwing a bight of the rope around a projecting pinnacle on the upper side, we climbed up, hand over hand, and thus effected a crossing. We were now obliged to travel slowly, with frequent rests. In that rare atmosphere, after taking seventy or eighty steps, our breath would be gone, our muscles grew tired and strained, and we experienced all the sensations of extreme fatigue. An instant's pause, however, was sufficient to recover strength and breath, and we would start again. The wind, which we had not felt while climbing the steepest part of the mountain, now again blew furiously, and we began to suffer from the cold. Our course—directed still diagonally towards the left, thus shunning the severe exertion of climbing straight up the dome, although at an ordinary altitude the slope would be deemed easy—brought us first to the southwest peak. This is a long, exceedingly sharp, narrow ridge, springing out from the main dome for a mile into mid-air. The ridge affords not over ten or twelve feet of foothold on top, and the sides descend almost vertically. On the right side the snow lay firm and smooth for a few feet on top, and then descended in a steep, unbroken sheet, like an immense flowing curtain, into the tremendous basin which lies on the west side of the mountain between the southern and northern peaks, and which is inclosed by them as by two mighty arms. The snow on the top and left crest of the ridge was broken into high, sharp pinnacles, with cracks and fissures extending to the rocks a few feet below. The left side, too steep for the snow to lie on, was vertical, bare rock. The wind blew so violently that we were obliged to brace ourselves with our Alpine staffs and use great caution to guard against being swept off the ridge. We threw ourselves behind the pinnacles or into the cracks every seventy steps, for rest and shelter against the bitter, piercing wind. Hastening forward in this way along the dizzy, narrow, and precarious ridge, we reached at length the highest point. Sheltered behind a pinnacle of ice we rested a moment, took out our flags and fastened them upon the Alpine staffs, and then, standing erect in the furious blast, waved them in triumph with three cheers. We stood a moment upon that narrow summit, bracing ourselves against the tempest to view the prospect. The whole country was shrouded in a dense sea of smoke, above which the mountain towered two thousand feet in the clear, cloudless ether. A solitary peak far to the southeast, doubtless Mount Adams, and one or two others in the extreme northern horizon, alone protruded above the pall. On every side of the mountain were deep gorges falling off precipitously thousands of feet, and from these the thunderous sound of avalanches would rise occasionally. Far below were the wide extended glaciers already described. The wind was now a perfect tempest, and bitterly cold; smoke and mist were flying about the base of the mountain, half hiding, half revealing its gigantic outlines; and the whole scene was sublimely awful.

It was now five P. M. We had spent eleven hours of unremitted toil in making the ascent, and, thoroughly fatigued, and chilled by the cold, bitter gale, we saw ourselves obliged to pass the night on the summit without shelter or food, except our meagre lunch. It would have been impossible to descend the mountain before nightfall, and sure destruction to attempt it in darkness. We concluded to return to a mass of rocks not far below, and there pass the night as best we could, burrowing in the loose *debris*.

DISCOVERY OF A CRATER CAVERN.

The middle peak of the mountain, however, was evidently the highest, and we determined to first visit it. Retracing our steps along the narrow crest of Peak Success, as we named the scene of our triumph, we crossed an intervening depression in the dome, and ascended the middle peak, about a mile distant and two hundred feet higher than Peak Success. Climbing over a rocky ridge which crowns the summit, we found ourselves within a circular crater two hundred yards in diameter, filled with a solid bed of snow, and inclosed with a rim of rocks projecting above the snow all around. As we were crossing the crater on the snow, Van Trump detected the odor of sulphur, and then the next instant numerous jets of steam and smoke were observed issuing from the crevices of the rocks which formed the rim on the northern side. Never was a discovery more welcome.

A NIGHT WITHIN THE VOLCANO.

Hastening forward, we both exclaimed, as we warmed our chilled and benumbed extremities over one of Pluto's fires, and here we would pass the night, secure against freezing to death, at least. These jets were from the size of that of a large steam-pipe to a faint, scarcely perceptible emission, and issued all along the rim among the loose rocks on the northern side for more than half the circumference of the crater. At intervals they would puff off more strongly, and the smoke would collect in a cloud until blown aside and scattered by the wind, and then their force would abate for a time.

A deep cavern, extending into and under the ice, and formed by the action of heat, was found. Its roof was a dome of brilliant green ice with long icicles pendant from it, while its floor, composed of the rocks and *debris* which formed the side of the crater, descended at an angle of thirty degrees. Forty feet within its mouth we built a wall of stones, inclosing a space five or six feet around a strong jet of steam and heat. Unlike the angular, broken rocks met with elsewhere, within the crater we found well-rounded boulders and stones of all sizes worn as smooth by the trituration of the crater as by the action of water. Nowhere, however, did we observe any new lava or other evidences of recent volcanic action excepting these issues of steam and smoke. Inclosed within the rude shelter thus hastily constructed, we discussed our future prospects while we ate our lunch and warmed ourselves at our natural register. The heat of the orifice was too great to bear for more than an instant, but the steam wet us, the smell of sulphur was nauseating, and the cold was so severe that our clothes, saturated with the steam, froze stiff when turned away from the heated jet. The wind outside roared and whistled, but it did not much affect us, secure within our cavern, except when an occasional gust came down perpendicularly. However, we passed a most miserable night, freezing on one side, and in a hot steam-sulphur bath on the other.

The dawn at last slowly broke, cold and gray. The tempest howled still wilder. As it grew light, dense masses of driven mist went sweeping by overhead and completely hid the sun, and enveloped the mountain so as to conceal objects scarce a hundred feet distant. We watched and waited with great anxiety, fearing a storm which might detain us there for days without food or shelter, or, worse yet, snow, which would render the descent more perilous, or most likely impossible. And when, at nine A.M., an occasional rift in the driving mist gave a glimpse of blue sky, we made haste to descend. First, however, I deposited the brass plate inscribed with our names in a cleft in a large boulder on the highest summit—a huge mound of rocks on the east side of our crater of refuge, which we named Crater Peak—placed the canteen alongside, and covered it with a large stone. I was then literally freezing in the cold, piercing blast, and was glad to hurry back to the crater, breathless and benumbed.

DISCOVERY OF AN ADDITIONAL CRATER.

We left our den of refuge at length, after exercising violently to start the blood through our limbs, and, in attempting to pass around the rocky summit, discovered a second crater, larger than the first, perhaps three hundred yards in diameter. It is circular-filled with a bed of snow, with a rocky rim all around and numerous jets of steam issuing from the rocks on the northern side. Both craters are inclined—the first to the west, and the latter to the east with a much steeper inclination, about thirty degrees. The rim of the second crater is higher, or the snow-field inside lower, than that of the first, and upon the east rises in a rocky wall thirty feet above the snow within. From the summit we obtained a view of the northern peak still partially enveloped in the driving mist. It appeared about a mile distant, several hundred feet lower than the center peak, and separated from it by a deeper, more abrupt depression or gap than that separating Crater and Success peaks. Like the latter, too, it is a sharp, narrow ridge springing out from the main mountain, and swept bare of snow on its summit by the wind. The weather was still too threatening, the glimpses of the sun and sky through the thick, flying scud, were too few and fugitive, to warrant us in visiting this peak, which we named Peak Takhoma, to perpetuate the Indian name of the mountain.

A PERILOUS DESCENT.

Our route back was the same as on the ascent. At the steepest and most perilous point in descending the steep gutter where we had been forced to cut steps in the ice, we fastened one end of the rope as securely as possible to a projecting rock, and lowered ourselves down by it as far as it reached, thereby passing the place with comparative safety. We were forced to abandon the rope here, having no means of unfastening it from the rock above. We reached the foot of the rocky ledge or ridge, where the real difficulties and dangers of the ascent commenced, at 1.30 P.M., four and a half hours after leaving the crater. We had been seven and a half hours in ascending from this point to the summit of Peak Success, and in both cases we toiled hard and lost no time.

We now struck out rapidly and joyfully for camp. When nearly there Van Trump, in attempting to descend a snow-bank without his creepers, which he had taken off for greater ease in walking, fell, shot like lightning forty feet down the steep incline, and struck among some loose rocks at its foot with such force as to rebound several feet into the air; his face and hands were badly skinned, and he received

some severe bruises and a deep, wide gash upon his thigh. Fortunately the camp was not far distant, and thither with great pain and very slowly he managed to hobble. Once there I soon started a blazing fire, made coffee, and roasted choice morsels of a marmot, Sluiskin having killed and dressed four of these animals during our absence. Their flesh, like the badger's, is extremely muscular and tough, and has a strong, disagreeable, doggy odor.

Towards the close of our repast, we observed the Indian approaching with his head down, and walking slowly and wearily as though tired by a long tramp. He raised his head as he came nearer, and, seeing us for the first time, stopped short, gazed long and fixedly, and then slowly drew near, eyeing us closely the while, as if to see whether we were real flesh and blood or disembodied ghosts fresh from the evil demon of Takhoma. He seemed both astonished and delighted to find us safe back, and kept repeating that we were strong men and had brave hearts: "Skookum tilicum, skookum tumtum." He expected never to see us again, he said, and had resolved to start the next morning for Olympia to report our destruction.

The weather was still raw and cold. A dense cloud overhung and shrouded the triple crown of Takhoma and made us rejoice at our timely descent. The scanty shelter afforded by the few balsam firs about our camp had been destroyed by the fire, and the situation was terribly exposed to the chilly and piercing wind that blew from the great ice fields. Van Trump, however, was too badly hurt to think of moving that night. Heating some large stones we placed them at our feet, and closely wrapped in our blankets slept soundly upon the open ground, although we awoke in the morning benumbed and chilled.

We found many fresh tracks and signs of the mountain sheep upon the snow-fields, and hair and wool rubbed off upon rocks, and places where they had lain at night. The mountain-sheep of Takhoma is much larger than the common goat, and is found only upon the loftiest and most secluded peaks of the Cascade Range. Even Sluiskin, a skillful hunter and accustomed to the pursuit of this animal for years, failed to kill one, notwithstanding he hunted assiduously during our entire stay upon the mountain, three days. Sluiskin was greatly chagrined at his failure, and promised to bring each of us a sheep-skin the following summer, a promise which he faithfully fulfilled.

THE GLACIAL SYSTEM OF TAKHOMA.

The glacial system of Takhoma is stupendous. The mountain is really the grand focal center and summit of a region larger than Massachusetts, and the five large rivers which water this region all find their sources in its vast glaciers. They are the Cowlitz, which empties into the Columbia; the White, Puyallup, and Nisqually rivers, which empty into Puget Sound sixty, forty, and twelve miles respectively north of Olympia; and the Wenass, which flows eastward through the range and empties into the Yakima, which joins the Columbia four hundred miles above its mouth. These are all large streams from seventy to a hundred miles in length. The White, Pyallup, and Cowlitz rivers are each navigable for steamboats for some thirty miles, and like the Nisqually show their glacial origin by their white and turgid water, which indeed gives the former its name.

The southwestern sides of the mountain furnish the glaciers which form the sources of the Nisqually, and one of these, at Sluiskin's Falls, has been already described. The main Nisqually glacier issues from the deep abyss overhung by the vast rock along the face of which our route of ascent lay, and extends in a narrow and somewhat crooked canyon for two miles. The ice at its extremity rises in an abrupt wall five hundred feet high, and a noisy torrent pours out with great force from beneath. This feature is characteristic of every glacier. The main Cowlitz glacier issues from the southeast side, just to the right of our ridge of ascent. Its head fills a deep gorge at the foot of the eastern front or face of the great mass of rock just referred to, and the southern face of which overhangs the main Nisqually glacier. Thus the heads of these glaciers are separated only by this great rock, and are probably not more than half a mile apart, while their mouths are three miles apart. Several smaller glaciers serve to swell the waters of the Cowlitz. In like manner the glaciers from the western side form the Puyallup, and those from the northern and northwestern sides the White River. The principal White River glacier is nearly ten miles long, and its width is from two to four miles. Its depth, of the thickness of its ice, must be thousands of feet. Streams and rivulets under the heat of the sun flow down its surface until swallowed by the crevasses, and a lakelet of deep blue water an eighth of a mile in diameter has been observed upon the solid ice. Pouring down from the mountain, the ice by its immense weight and force has gouged out a mass upon the northeastern side a mile in thickness. The geological formation of Takhoma poorly resists the eroding power of these mighty glaciers, for it seems to be composed not of solid rock, but of a basaltic conglomerate in strata, as though the volcanic force had burst through and rent in pieces some earlier basaltic outflow, and had heaped up this vast pile from the fragments in successive strata. On every side the mountain is slowly disintegrating.

What other peak can offer to scientific examination or to the admiration of tourists fourteen living glaciers of such magnitude, issuing from every side, or such grandeur, beauty, and variety of scenery?

At daylight we broke up our camp at Sluiskin's Falls, and moved slowly, on account of Van Trump's hurt, down the ridge about five miles to Clear Creek, where we again regaled ourselves upon a hearty repast of marmots, or "raw dog," as Van Trump styled them in derision both of the viand and of the cookery. I was convinced from the lay of the country that Clear Creek flowed into the Nisqually, or was, perhaps, the main stream itself, and that the most direct and feasible route back to Bear Prairie would be found by following down the valley of these streams to the trail leading from the Nisqqally to Bear Prairie. Besides, it was evidently impossible for Van Trump in his bruised and injured state, to retrace our rough route over the mountains. Leaving him as comfortable as possible, with all our scanty supply of flour and marmots, sufficient to last him nearly a week in case of need, I started immediately after dinner, with Sluiskin leading the way, to explore this new route. The Indian had opposed the attempt strenuously, insisting with much urgency that the stream flowed through canyons impossible for us to traverse. He now gradually veered away from the course of the stream, until ere long he was leading directly up the steep mountain range upon our former route, when I called him back peremptorily, and kept him in the rear for a little distance. Traveling through open timber, over ground rapidly descending, we came at the end of two miles to where the stream is hemmed in between one of the long ridges or spurs from Takhoma and the high mountain-chain on the south. The stream, receiving many affluents on both sides, its clear waters soon discolored by the yeasty glacial torrents, here loses its peaceful flow, and for upwards of three miles rushes furiously down a narrow, broken, and rocky bed in a succession of falls and cascades of great picturesque beauty. With much toil and difficulty we picked our way over a wide, "talus" of huge, broken granite blocks and bowlders, along the foot of a vast mountain of solid granite on the south side of the river, until near the end of the defile, then crossed the stream and soon after encountered a still larger branch coming from the north, direct from Takhoma, the product, doubtless, of the glaciers on the southern and southwestern sides. Fording this branch just above its confluence with the other, we followed the general course of the river, now unmistakably the Nisqually, for about four miles; then, leaving it, we struck off nearly south through the forest for three miles, and emerged upon the Bear Prairie. The distance was about thirteen miles from where we left Van Trump, and we were only some six hours in traveling it, while it took seventeen hours of terribly severe work to make the mountain-route under Sluiskin's guidance.

Without his help on the shorter route, too, it would have taken me more than twice the time it did. For the manner in which, after entering the defile of the Nisqually, Sluiskin again took the lead and proceeded in a direct and unhesitating course, securing every advantage of the ground, availing himself of the wide, rocky bars along the river, crossing and recrossing the milky flood which rushed along with terrific swiftness and fury, and occasionally forcing his way through the thick timber and underbrush in order to cut off wide bends of the river, and at length leaving it and striking boldly through the forest to Bear Prairie, proved him familiar with every foot of the country. His objections to the route evidently arose from the jealousy so common with his people of further exploration of the country by the whites. As long as they keep within the limits already known and explored, they are faithful and indefatigable guides, but they invariably interpose every obstacle their ingenuity can suggest to deter the adventurous mountaineer from exposing the few last hidden recesses that remain unexplored.

Mr. Coleman was found safe in camp, and seemed too glad to see us to think of reproaching us for our summary abandonment. He said in attempting to follow us he climbed up so precipitous a place, that, encumbered with his heavy pack, he could neither advance nor recede. He was compelled, therefore, to throw off his pack, which rolled to the very bottom of the mountain, and being thus delivered of his necessary outfit, he was forced to return to camp. He had been unable to find his pack, but having come across some cricketer's spikes among his remaining effects, he was resolved to continue his trip to, and make the ascent of Rainier by himself; he had just completed his preparations, and especially had deposited on top of the lofty mountain which overlooked the prairie two caches, or stores, of provisions.

At daylight next morning, Sluiskin, with his little boy riding one of his own ponies, himself riding our little calico-colored pack horse, now well rested and saucy, started back for Van Trump, with directions to meet us at the trail on the Nisqually. A heavy, drizzling rain set in soon afterwards. Mr. Coleman, who had gone early to bring in the contents of his mountain top caches, returned about noon with a very small bundle, and packing our traps upon Sluiskin's other pony, we moved over to the rendezvous, pitched Coleman's large gum-sheet as a partial shelter, made a rousing fire and tried to be comfortable. Late in the afternoon the pony set up a violent neighing, and in a few minutes Van Trump, and Sluiskin with his little boy behind him, rode up drenched to the skin. By following the bed of the river, frequently crossing and recrossing, the Indian had managed to ride to the very foot of the Nisqually defile, when, leaving the horses in his boy's care, he hastened to Van Trump and carefully led and assisted him down.

ORNAMENTAL DOORWAY. DESIGNED BY PROF. V. MYSKOVSZKY, KASCHAU.—(*From the Workshop*)

PROJECT OF A GREAT AQUARIUM.

AT the Exhibition to be held at Paris, in 1878, M. Toselli proposes to construct a great aquarium to serve for the display of diving-bells, instruments for raising sunken ships and their cargoes, etc.—*Les Mondes.*

BRITISH PATENTS.

THE number of patents applied for in England during the year 1876 was 5,000, the largest by far which has ever been known. There has been a gradual increase for some years past, but the jump from 1875, when the number was 4,561, is very large.